MP MASTER
MA36326

MOTOROLA

DIGITAL FREQUENCY METER

MODEL S1324 AND DEVIATION MODEL S1325

or

SLN-6365-A

MOTOROLA INC. Communications Division

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68P81069A08
Issue - O

500 MHz PRESCALER
ASSEMBLY # 1P83554F39
SCHEMATIC # 73P83554F39
BLOCK DIAGRAM #39120

The functional sections of this board are: the input limiter, Schmitt trigger, divide-by-four circuit, cathode follower output and time base expander circuitry.

A signal applied to the RF Input is routed through hybrid-limiting amplifier U1 to the base of Q1. Q1, Q2 form a Schmitt trigger with the trigger level controlled by potentiometer R8. Output of the Schmitt trigger, Q2 collector, is applied to divide-by-two circuit U2. Output of U2 is applied to U3, divide-by-two circuit. The output amplifier-buffer is the cathode follower, Q3. Output is applied to the 200 MHz Amplifier and Gate Assembly.

The time base expander circuit consists of U5, a dual J-K flip-flop and U4, Quad input Nand gates.

PARTS LIST
500 MHz PRESCALER ASSEMBLY

CAPACITORS

Ref.	Motorola No.
C1	21D82187B14
C2	21P84309A23
C3	21P84309A24
C4	21P84209D48
C5	21P84309A23
C6	21P84309A23
C7	21D82187B14
C8	21D82187B14
C9	21D82187B14
C10	21D82187B14
C11	21D82187B14
C12	21D82187B14
C13	21D82187B14
C14	21D83068E04
C15	21D83068E04
C16	21P84309A25
C17	21P84309A23
C18	21D83068E04
C19	21P84209D49
C20	21P84309A23
C21	21P84309A23
C22	21P84309A23

DIODES

Ref.	Motorola No.
CR1	48P84309A58
CR2	48P84309A58
CR3	48P84309A57

TRANSISTORS

Q1	48P84209D47
Q2	48P84209D47
Q3	48P84309A61

RESISTORS

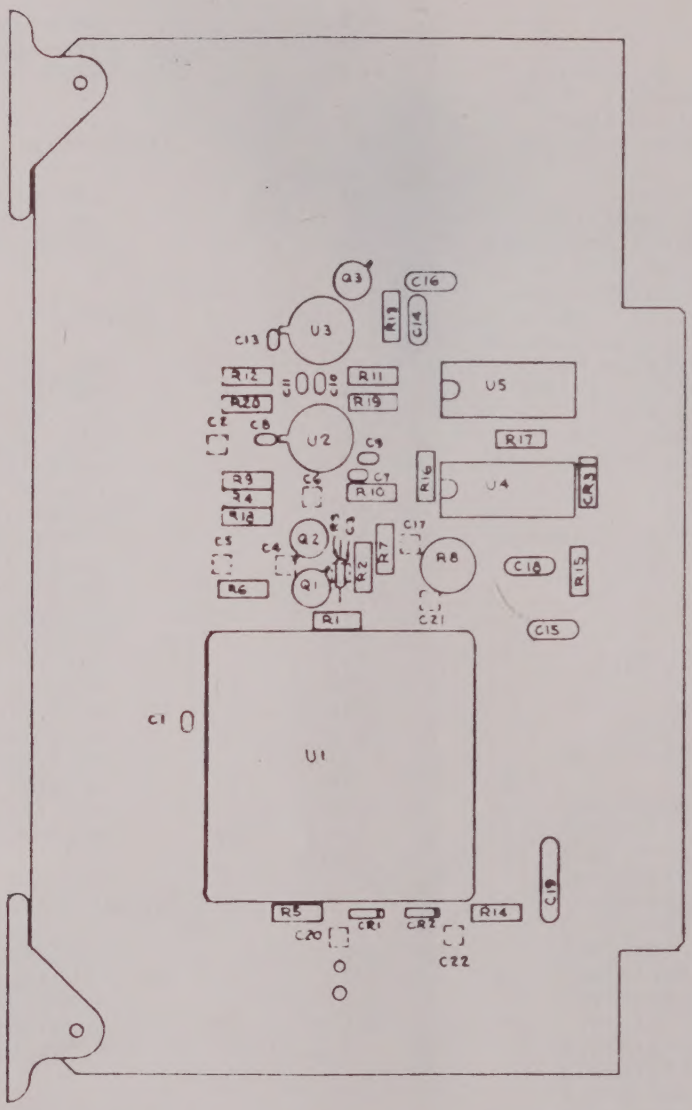
R1	6R131524
R2	6R131274
R3	6S185A29
R4	6R129431
R5	6R129709
R6	6R131275
R7	6R129431
R8	18P84209D50
R9	6R124A97
R10	6K129236
R11	6R129526
R12	6K129236
R13	6R129818
R14	6R129667
R15	6R129668
R16	6R129709
R17	6R129709
R18	6R124A23
R19	6R129669
R20	6R129669

INTEGRATED CIRCUITS

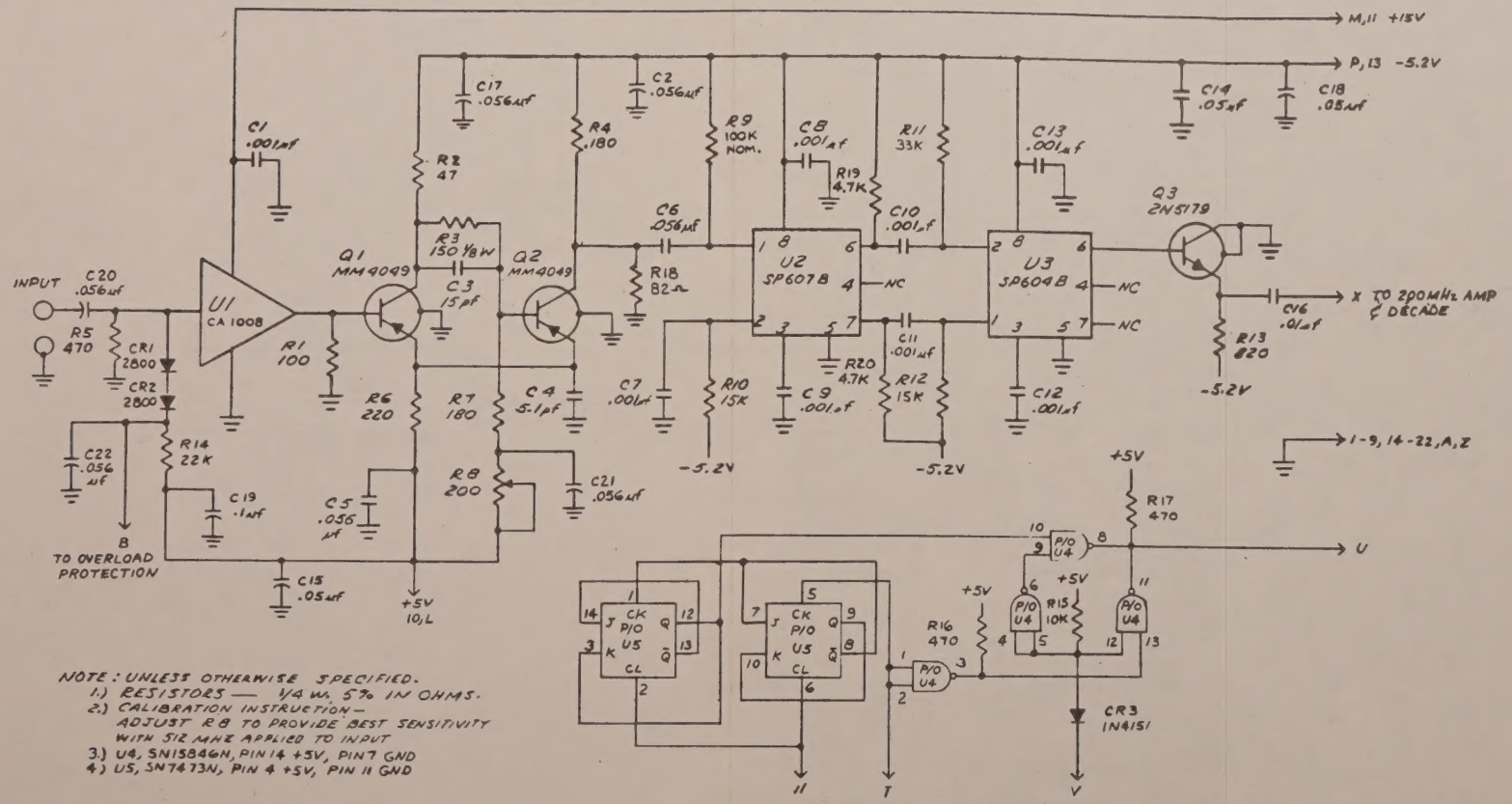
U1	1P84209D44
U2	51P84209D45
U3	51P84209D46
U4	51P84309A71
U5	51P84309A72

MISCELLANEOUS

	29P84209D51
	29P84209D52
	66P84309A93
	14P84209D53
	14P84209D54



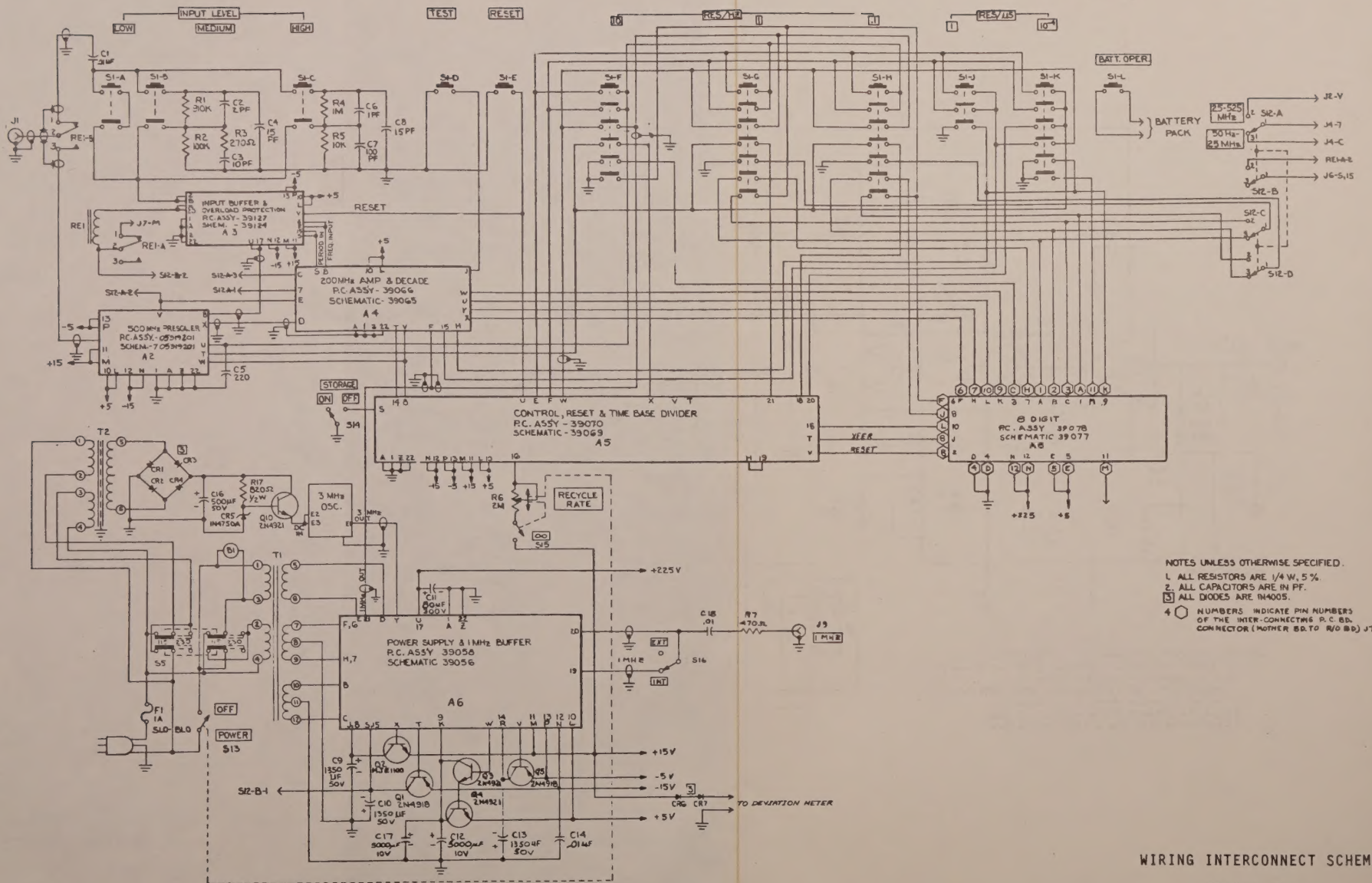
500 MHz PRESCALER ASSEMBLY #05319201



NOTE: UNLESS OTHERWISE SPECIFIED.
1.) RESISTORS — 1/4 W, 5% IN OHMS.
2.) CALIBRATION INSTRUCTION — ADJUST R8 TO PROVIDE BEST SENSITIVITY WITH 512 MHZ APPLIED TO INPUT
3.) U4, SN15846N, PIN 14 +5V, PIN 7 GND
4.) U5, SN7473N, PIN 4 +5V, PIN 11 GND

500 MHz PRESCALER SCHEMATIC

#7-05319201 REV B



NOTES UNLESS OTHERWISE SPECIFIED.

1. ALL RESISTORS ARE 1/4 W, 5%
2. ALL CAPACITORS ARE IN PF.
3. ALL DIODES ARE IN4005.
4. NUMBERS INDICATE PIN NUMBERS OF THE INTER-CONNECTING P.C. BD. CONNECTOR (MOTHER BD. TO R/O BD.) J7

WIRING INTERCONNECT SCHEMATIC

#39120 REV C

S1324A-3-74 ADDENDUM

MOTOROLA INC.
Communications Division

MANUAL CHANGE SHEET
MODEL S1324A

Change the following part numbers:

	OLD	NEW
Capacitor, 1pF	21P84250C34	21P84250C38
Resistor, 470Ω, 1/4W, 5%	18P84250C32	18P84250C34
Resistor, 1k, Temp. Sensing	18P84250C33	18P84250C36
Resistor, 43Ω, 1/8W, 5%	18P84250C34	18P84250C37
Transistor, 15840	48P84250C23	48P84309A67
S1324A Block Diagram	73P84250C32	63P84250C62
Power Supply & 1MHz Shaper Schematic	73P84250C33	63P84250C63
500MHz Prescaler Schematic	73P84250C34	63P84250C64
200MHz Amplifier & Decade Schematic	73P84250C35	63P84250C65
Control, Reset, & Timebase Schematic	73P84250C36	63P84250C66
Input Buffer & Overload Schematic	73P84250C37	63P84250C67
8 Digit Readout Schematic	73P84250C38	63P84250C68
Front Panel Subassembly	1P84250C32	1P84250C69
Rear Panel Subassembly	1P84250C33	1P84250C70
Right Gusset Assembly	1P84250C34	1P84250C71

Change the following pages:

6-4	Should read ...	CR6	A6	48P83698E06
		CR7	A6	48P83698E06
6-10	Should read ...	S1	C1	40P84250C04
		S2	C1	40P84250C04
		S3	C2	40P84250C04
6-12	Should read ...	Q2	B3	48P84305A20
		Q7	B3	48P84305A20
6-16	Should read ...	U18	A6	51P84250C35
6-19	Add:	51P84250C35		SN7490 (Integrated Circuits)

NOTE

When communicating with any Motorola Parts Depot regarding parts or service for this instrument, be sure to specify the complete nomenclature as follows:

Model S1324A (SLN 6365A)
Digital Frequency Meter

Change the following pages:

6-4	Should read ...	Q2	B6	48P84250C77
		Q3	C6	48P84204D13
		Q4	C2	48P84204D13
		Q10	B6	48P84204D13
6-5	Change:	Q2,2N4921 to Q2,MJE11D0		
6-6	Should read ...	R27	B5	6R400058
6-7	Change:	R27,270 Ω to R27,560 Ω (Schematic)		
6-20	Add:	6R400058	560 Ω, 1/2 W, 5% (Resistors)	
	Should read ...	48P84204D13	2N4921 (Transistors)	
	Add:	48P84250C77	MJE1100 (Transistors)	

SLN1006A-1-71 4 of 5

	Add:	F5	A2	65A10266 Fuse, 10A, FB, 3AG (Miscellaneous)

SLN1006A-1-71 5 of 5

Add: F5 to section A2 of P.C. Board.

FOREWORD

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material inside be damaged.

The equipment should be unpacked immediately, examined for damage, and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

MOTOROLA INC.
Communications Division Parts Dept.
1313 E. Algonquin Road
Schaumburg, Illinois 60172
Phone (312) 397-3500
TWX 910-693-1592

Include model number and serial number when referring to the instrument for any reason.

Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

Warranty

Motorola instrument equipment, other than tubes and fuses, is warranted by Motorola for a period of one year after delivery to the original purchaser, against defects in design, material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the address indicated herein for that purpose, and to replace any defective parts thereof.

This warranty is in lieu of all other warranties, expressed or implied, and all other obligations or liabilities on Motorola's part.

Readout tubes carry their own 90-day manufacturer's warranty.

This warranty is effective for one year after delivery to the original purchaser, when the instrument is returned, transportation charges prepaid, by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at the manufacturer's then prevailing labor rates. In this case, an estimate will be submitted before the work is started.

Repair / Recalibration

Before shipping the instrument, notify the Parts Department at the address shown, of the service required. Refer to the instrument by model number and serial number. On receipt of the information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

MOTOROLA INC.
Communications Division Parts Dept.

WESTERN AREA PARTS
1170 Chess Drive
Foster City, San Mateo,
California 94404
Phone: 415-349-3111
TWX: 910-375-3877

MIDWEST AREA PARTS
1313 E. Algonquin Road
Schaumburg, Illinois 60172
Phone: 312-397-3500
TWX: 910-693-1592

EAST CENTRAL AREA PARTS
12955 Snow Road
Parma, Ohio 44130
Phone: 216-267-2210
TWX: 810-421-8845

EASTERN AREA PARTS
85 Harristown Road
Glen Rock, New Jersey 07452
Phone: 201-447-4000
TWX: 710-988-5602

PACIFIC SOUTHWESTERN AREA PARTS
2333 Utah Avenue
El Segundo, California 90245
Phone: 213-644-1101
TWX: 910-348-6278

SOUTHWESTERN AREA PARTS
3320 Belt Line Road
Dallas, Texas 75234
Phone: 214-241-2151
TWX: 910-860-5505

SOUTHEASTERN AREA PARTS
South Perimeter Hwy
Forest Park, Georgia 30050
Phone: 404-762-6183
TWX: 810-751-8300

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Chapter 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Model S1324A is a solid-state digital frequency meter capable of measuring frequency from 50Hz to 525MHz. The instrument will also measure period and multiple periods from 50Hz to 1MHz.

1.2 STANDARD FEATURES

The Model S1324A is designed for simple, reliable operation and easy maintenance. Its circuitry is completely solid-state and modularized on plug-in printed-circuit boards. The eight-digit in-line readout displays a frequency continuously until the end of the next measurement cycle.

Automatic decimal point and units-of-measure indicators are provided for all frequency (rate and period) measurements. All measuring functions of the Model S1324A are controlled by a row of front panel pushbutton switches. The TEST pushbutton applies the internal 1MHz reference to the input of the counting circuits providing an operational check of almost all circuits within the unit.

The RESET pushbutton allows the operator to manually reset the counter to zero. The DISPLAY control, which varies the interval between successive measurement periods, is combined with the power switch in a single front panel control. The GATE light indicates when a counting cycle is in progress.

Signals are applied to the counter through a single front panel BNC connector. A toggle switch (which controls a coaxial relay) is set to one of two positions appropriate to the input signal frequency.

Display storage may be defeated by means of a rear panel toggle switch, if it is desired to observe the cycling of the readout tubes during the counting cycle. A rear panel BNC connector (1MHz INT/EXT) provides a 1MHz reference signal when the associated toggle switch is set to INT. If it is desired to use an external frequency reference, the switch is set to EXT and the reference signal applied to the BNC connector.

The high frequency (25-525MHz, 50Ω) input is protected against accidental overloads. When an overload occurs, the input signal is switched to the low frequency amplifier, which can withstand much higher voltages.

1.3 OPTIONAL FEATURES

Battery operation is an option which may be added to the Model S1324A; it is installed only at the factory. Rechargeable batteries provide 1 hour or more of continuous operation. A front panel momentary pushbutton controls application of power to the Model S1324A when the battery option is installed.

A space is provided below the S1324A for the Measurements Company Deviation Meter Model SLN-1005A allowing the basic frequency meter to provide deviation meter capabilities.

1.4 SPECIFICATIONS

The specifications for the Model S1324A are listed in Table 1.1.

TABLE 1.1 SPECIFICATIONS

Frequency Measurements	Range:	50Hz to 25MHz (nominal 125MHz). 25MHz to 525MHz (prescaler).
	Sensitivity:	50mV rms.
	Resolution:	0.1, 1, and 10Hz.
	Accuracy:	±1 count ±time base accuracy.
	Reads In:	Hz, kHz, or MHz with positioned decimal point.
	Self Check:	Counts 1MHz to selected resolution.
Period Average Measurements	Range:	50Hz to 1MHz.
	Periods Averaged:	1 or 10^4.
	Accuracy:	±1 count ±time base accuracy ±trigger error. Trigger error is less than 0.3% of one period ÷ periods averaged for signals with 40 dB or better signal-to-noise ratio.
	Sensitivity:	50mV rms.
	Resolution:	1 or 10^{-4} sec.
	Reads In:	S with positioned decimal point.
Time Base	Crystal Frequency:	3MHz (divided down to 1MHz).
	Aging Rate:	Better than ±3 parts in 10^7/24 hours.
	Temperature Stability:	Less than ±2 parts in 10^{10}/°C.

TABLE 1.1 SPECIFICATIONS (Cont'd)

General	Registration:	8 digits in-line.
	Display Storage:	Provides a continuous display of the most recent measurement. Rear panel switch defeats storage.
	Sample Rate:	0.2 seconds to 5 seconds independent of gate or hold time until manual reset.
	Operating Temperature Range:	0°C to +50°C.
	Input Impedance:	1MΩ shunted by 50 pF or less (50Hz - 25MHz range); 50Ω nominal (25MHz - 525MHz range).
	Attenuation:	Step attenuator with factors of 1, 10, and 100 (LOW, MED, & HIGH respectively) in 50Hz - 25MHz range only.
	Overload Without Damage:	75V p-p on LOW, 200V p-p on MED, 200V p-p on HIGH, in 50Hz - 25MHz range. 10V p-p in 25 - 525MHz range (see "INPUT PROTECTION" below).
	Power:	115/230V ac ±10%, 50-60Hz, 50 watts average.
	Dimensions:	9-13/16"w x 8-3/4"h x 18-1/4"d.
	Weight:	23 pounds.
	Input Protection:	Input protection in the 25 - 525MHz range is provided by a fast-acting (approximately 1msec) coaxial relay which switches the input signal to the 25MHz amplifier if the input exceeds approximately 8V rms.

TABLE SPECIFICATIONS (Cont'd)

General	Deviation Meter (Motorola Model S1325A): *See Model S1325A (SLN-1005A) Deviation Meter Instruction Manual for operation and maintenance procedures.*	Physical and electrical interfacing is provided in the Model S1324A cabinet for the SLN-1005A Deviation Meter, which is installed in the 4" x 9" front panel space. +13.6V dc ±10% @ 300 mA is provided to power the Deviation Meter.

WARNING

HAZARDOUS ELECTRICAL POTENTIALS ARE PRESENT INSIDE THE EQUIPMENT CABINET. DO NOT REMOVE CABINET COVERS UNTIL LINE POWER IS DISCONNECTED.

Service personnel should be thoroughly familiar with the instrument prior to performing any maintenance procedures.

Chapter 2

INSTALLATION

2.1 INTRODUCTION

This chapter presents procedures for inspection and initial installation of the S1324A counter. Reshipment instructions have been included should it become necessary to return the instrument to the factory for service or repair.

2.2 RECEIVING INSPECTION

Before accepting the instrument from the shipper, inspect the instrument's shipping container for signs of external shipping damage. Any sign of such damage must be noted by both the shipper and customer, and should be reported to the insurance investigator.

As soon as the instrument is unpacked, inspect it for shipping damage. Check for scratches or dents, broken or cracked knobs, and damaged connectors. Should any damage be found, notify your nearest Motorola representative--do not use the instrument until instructed to do so by the representative.

2.3 COOLING

The Model S1324A uses forced air cooling with the air intake located on the rear panel of the instrument. Make sure the air intake screen and filter is in place and clean before applying power to the instrument. Under no circumstance should the air intake be obstructed when the instrument is operating.

2.4 POWER CONNECTION

The Model S1324A may be operated from 115 or 230-volt ac (±10%) power lines. The LINE switch on the rear panel permits quick conversion for operation from either voltage. Insert a narrow-blade screwdriver in the switch slot and slide the switch down for 230-volt operation ("230" marking exposed) or up for 115-volt operation ("115" marking exposed). The instrument is factory-supplied with a 115-volt fuse; be sure to replace this fuse for 230-volt operation--see Table 2.1.

CAUTION

Before connecting the instrument to an ac power line, make sure LINE switch is properly positioned for the line voltage to be used.

The Model S1324A is equipped with a standard three-conductor power cord that automatically grounds the unit when a matching power receptacle is available. An adapter which provides an instrument ground should be used whenever the power cord must be connected to a two-conductor outlet.

TABLE 2.1 115/230V POWER CONVERSION

Conversion	115 Volt	230 Volt
LINE switch	Up ("115")	Down ("230")
AC LINE fuse	1 amp slow-blow	0.5 amp slow-blow

2.5 INITIAL TURN-ON

This procedure checks the Model S1324A counter for any major internal shipping damage. Successful completion of the tests listed below should precede implementation of any Performance Test.

a) Place LINE switch to proper position (see Table 2.1) and connect the instrument to an ac power source.

b) Set DISPLAY/POWER switch to on and fully counterclockwise--display illuminates.

c) Place STORAGE switch to ON and set 1MHz INT/EXT switch to INT. Push TEST button to on.

d) Using Table 2.2 check Range switch settings and RESOLUTION pushbuttons for proper display indication.

2.6 PREPARATION FOR RESHIPMENT

Should it become necessary to reship the instrument, contact the nearest Motorola field office for shipping instructions. If possible use the original packaging materials or replace in accordance with MIL-P-116 and MIL-E-17555E. The field office can provide materials similar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument involved.

TABLE 2.2 TURN-ON TEST DISPLAY INDICATION

Range Switch Setting	Frequency/Period Resolution	Display Indication
50Hz - 25MHz	10Hz	001.00000MHz
	1Hz	01000.000KHz
	0.1Hz	1000000.0Hz
25 - 525MHz	10Hz	001.00000MHz
	1Hz	01.000000MHz
	0.1Hz	1.0000000MHz
Either Range	1μS	00000001μS
	10^{-7} S	0001.0000μS

Chapter 3

OPERATION

3.1 INTRODUCTION

This section describes the Model S1324A controls, connectors, and indicators. Information about factors which affect the accuracy of counter measurements is also presented. Finally, the step-by-step operating procedures are listed for each of the counter's basic functions. Figures 3.1 and 3.2 illustrate the Model S1324A front and rear panel controls, connectors, and indicators. Tables 3.1 and 3.2 provide a description of each function.

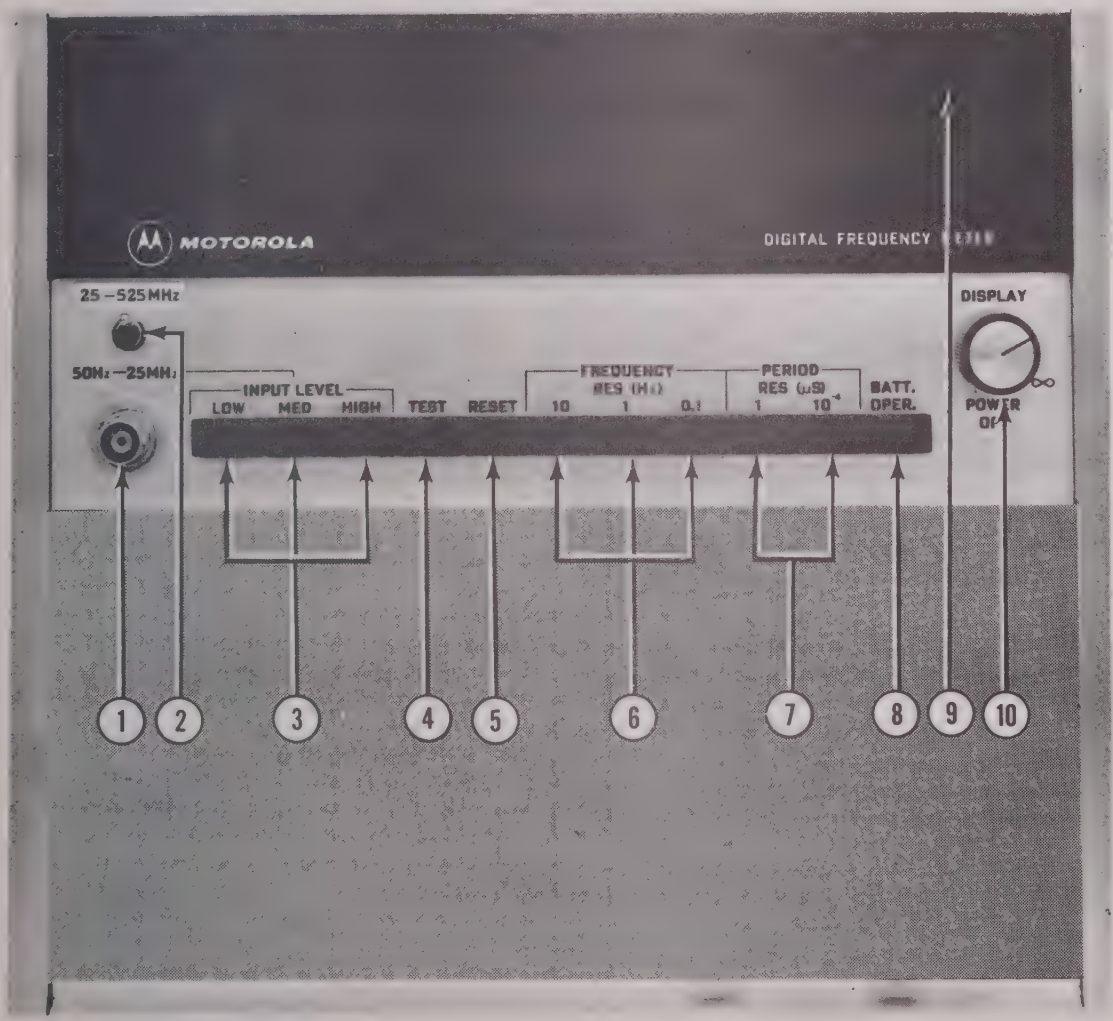


FIGURE 3.1 FRONT PANEL, MODEL S1324A

3.2 FRONT PANEL

Table 3.1 describes the function of all front panel controls, connectors, and indicators with Figure 3.1 providing location information.

TABLE 3.1 FRONT PANEL DESCRIPTION

Figure	Index	Name	Function	
3.1	1	"INPUT" (connector)	BNC	Accepts an external signal for both frequency and period measurements.
3.1	2	"RANGE" (switch)	50Hz-25MHz	Sets the counter to measure frequencies from 50Hz to 25MHz (will accept up to a nominal 125MHz in this position).
			25-525MHz	Sets the counter to measure frequencies from 25MHz to 525MHz.
3.1	3	INPUT LEVEL (pushbutton)	LOW MED HIGH	Selects attenuation networks which decrease the input by a factor of 1 (LOW), 10 (MED), and 100 (HIGH). These controls only attenuate when the RANGE switch, Index 2, is in the 50Hz-25MHz position.
3.1	4	TEST (pushbutton)		Allows instrument to self test the circuitry by measuring its internal oscillator freq. Operates only when 1MHz INT/EXT switch is in INT position.
3.1	5	RESET (pushbutton)		Manually resets the counter to zero, after which, the counter will begin its next counting cycle. This action [illegible] normal operation after [illegible]
3.1	6	[illegible] (pushbuttons)	10 1 0.1	Measures frequency by counting each input cycle during a selected time base period - 10, 1, or 0.1 seconds. These switches, in conjunction with the RANGE switch, also control the automatic decimal point and units-of-measure indicators.

TABLE 3.1 FRONT PANEL DESCRIPTION (Cont'd)

Figure	Index	Name	Function	
3.1	7	PERIOD RES (μS) (pushbuttons)	1 10^{-4}	Measures time of one or 10^4 periods of the input waveform.
3.1	8	BATT. OPER. (pushbutton)		This momentary-on switch permits counting of input signal while instrument is operating under battery power.
3.1	9	"DISPLAY" (indicator)	Readout	A polariod glass covers an 8-digit readout with positioned decimal point.
			Annunciator	Automatic units of measure and overload are displayed - MHz, KHz, Hz, μS, O.L., and Gate.
3.1	10	DISPLAY POWER OFF (switch)		This recycle-rate control turns the power on and off and sets the counter display time from 0.2 to 5 seconds.
			∞	When positioned at infinity, the counter displays the last measurement indefinitely or until the RESET pushbutton is depressed.

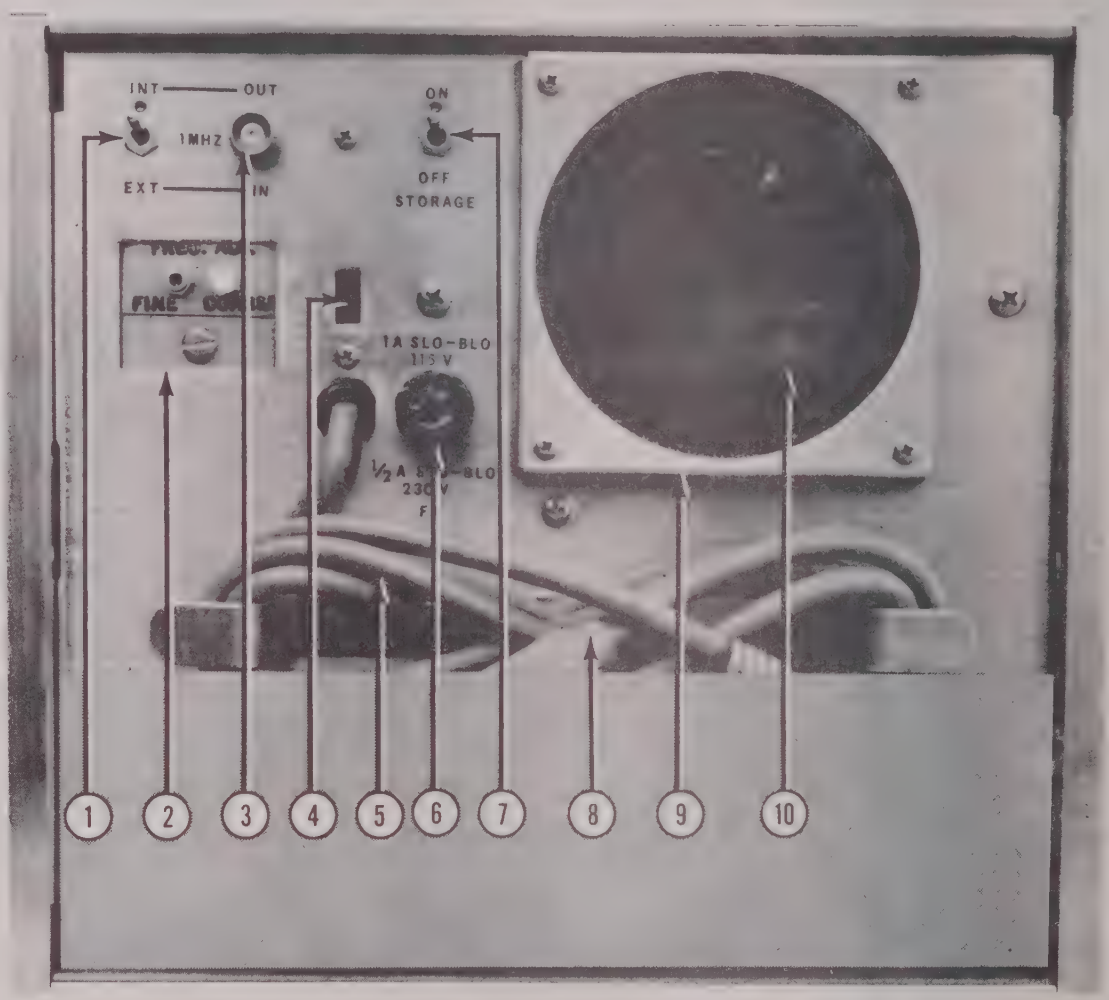


FIGURE 3.2 REAR PANEL, MODEL S1324A

3.3 REAR PANEL

Table 3.2 describes the function of all rear panel controls and connectors; Figure 3.2 provides location information.

TABLE 3.2 REAR PANEL DESCRIPTION

Figure	Index	Name	Function	
3.2	1	1MHz (switch)	INT	This position allows the counter to operate on the internal 1MHz time base frequency.
			EXT	This position allows the counter to operate using an external 1MHz signal connected to the rear panel 1MHz BNC connector (Index 3). [Signal strength minimum of 1V rms and a maximum of 2V rms.]
3.2	2	FREQ. ADJ. (controls)	COARSE	This screwdriver adjust, protected by a screw-on cap, is used for rough internal oscillator calibration.
			FINE	This screwdriver adjust is used for fine internal oscillator adjustment.
3.2	3	1MHz (connector)	OUT	Provides 1MHz signal out (.4V p-p) when 1MHz switch (Index 1) is in the INT position.
			IN	Acts as the input connector for a 1MHz external standard when the 1MHz switch (Index 1) is in the EXT position.
3.2	4	LINE (switch)	115	With this indication the unit will operate on 115V ac.
			230	With this indication the unit will operate on 230V ac. (Be sure to check fuse value, see Table 2.1)
3.2	5	POWER CORD (connector)		3-conductor grounded power cord.
3.2	6	FUSE		Contains the power fuse. 115V - 1A slo-blo 230V - .5A slo-blo
3.2	7	STORAGE (switch)	ON	In this position the last measurement is displayed until another is fed to the input.

TABLE 3.2 REAR PANEL DESCRIPTION (Cont'd)

Figure	Index	Name	Function	
3.2	7 (Cont'd)	STORAGE (switch)	OFF	In this position the readout will display the count cycling for each measurement.
3.2	8	CORD RACK		Carries power cord when the instrument is not in use.
3.2	9	FAN COVER		Holds filter and screen at fan intake opening.
3.2	10	FAN FILTER		This screens dust and particulate matter fro: the unit. Periodic cleaning is recommended to prevent overheating of the instrument.

3.4 ACCURACY OF MEASUREMENT

When the Model S1324A is used for critical measurements, several factors which may cause errors in counter measurements must be considered. The following paragraphs will illustrate the usual types of counter errors and present practical solutions to problems created by such errors.

3.4.1 OSCILLATOR STABILITY

Digital frequency measurements are subject to several types of errors. One of the most significant is inaccuracy of the timing interval, as determined by stability of the crystal-controlled oscillator. The three most common causes of oscillator instability are the following: inherent oscillator aging rate, operating temperature variations, and line (supply) voltage fluctuations.

Errors due to oscillator instability may be reduced by the following techniques:

(1) By leaving the power applied continuously, crystal aging will improve. The aging rate of an oscillator is greatest when it is first turned on. As an example, the high stability oscillator available for Motorola counters has an aging rate of 3 parts in 10^9/day after 72 hours continuous operation. After 60 days continuous operation, the aging rate may improve to 2 parts in 10^{10}/day.

(2) By frequent calibration with a frequency standard (periodic comparison against a primary frequency standard) the oscillator may be corrected for aging.

(3) By substituting an external oscillator with a higher stability than the standard internal oscillator, it is possible to decrease the normal oscillator instability errors.

3.4.2 GATING ERROR

Gating error is responsible for a possible error of ±1 count (in the least significant digit of the display) in almost all types of counter measurements. This error is possible because the incoming signal passing through the count gate is not synchronized with the time base pulses which control the gate.

The first or last cycle of the input signal may or may not pass through the gate during the selected measurement interval.

For high frequency measurements, the ±1 count gating error is insignificant compared to the total count. At low frequencies, however, this error may become important. For this reason, the period mode of measurement is normally used to obtain greater accuracy.

Gating error can be reduced by a factor of 10 by extending the interval of measurement by 10. The total count is multiplied by ten but the gating error remains ±1 count.

For example, if 10kHz is measured over a 0.1 second time base, the count indicated would be 1000 ±1 and the percentage of error would be ±0.1%. Measured over a 1 second time base, the count indicated would be 10,000 ±1 and the percentage of error would be reduced to ±0.01%.

3.4.3 COUNT ERROR PRODUCED BY NOISE IN FREQUENCY MEASUREMENTS

Noise superimposed on the input waveform may cause spurious count pulses to appear at the output of the input amplifier. If this noise should appear, an output pulse occurs, and is counted, each time the input signal crosses and re-crosses the shaper trigger level. Since an input signal cycle must usually have amplitude of at least 0.1 to 0.15 volts p-p to cause triggering, spurious counts can be eliminated by attenuating the total "input + noise" signal to a suitable amplitude.

It is important to have the attenuator control set properly when measuring signals under marginal conditions of noise.

3.4.4 LOADING ERROR

One frequently overlooked and generally not significant error may occur if the connection of the instrument to the external signal causes a frequency or amplitude shift of the external signal.

This error will only be noticed with signal sources of relatively high impedance (high frequency signal) in comparison to the input impedance and frequency rating of the counter.

For signals of sufficient amplitude, the loading error can be reduced by placing either a small coupling capacitor or a large resistor in series with the input signal. The isolating component should be located at the signal source so that it will also isolate the cable capacity.

3.4.5 TRIGGER ERROR

In addition to gating error, oscillator drift and loading errors, Period Measurement is subject to an error caused by noise on the input signal.

The total signal may be considered as an ideal noise-free signal with a superimposed noise signal. The noise (Vn) added to the ideal signal (Vs) may trigger the channel before or after the selected instant for triggering. The maximum error in time for a given p-p noise voltage (Vn) and the slope of the ideal signal (Vs) at the trigger level is:

$$t\ (\text{sec}) = \frac{Vn\ (\text{volts})}{\text{Slope}\ (\text{volts/sec})}$$

The maximum percent error is:

$$\text{Max. \% error} = \frac{t\ (\text{sec}) \times 100}{T\ (\text{sec})}$$

For a sine wave triggering at its zero crossover point:

$$\text{Max. \% error} = \frac{Vn\ (\text{volts}) \times 100}{Vs\ (\text{volts})}$$

This error effectively lengthens or shortens the period measurement. The percentage of error is given by the formula 100/T, where "T" is the trigger error (in seconds).

From the foregoing discussion, it can be seen that as the amplitude of signal voltage (Vs) is increased, the percentage of error is diminished.

Another way to reduce trigger error is to measure multiple periods of the gating signal. Since this error occurs only

with the first and last pulse of the measuring interval, the trigger error will be reduced by a factor of 1/M if the measurement is extended for M periods.

TABLE 3.3 TOTAL ERROR

Function	Errors Present
Frequency	Gating + Drift + Loading
Period	Gating + Drift + Trigger + Loading

The various errors add up in the following manner (as depicted in Table 3.3) to form the total error for each of the functions.

3.5 EQUIPMENT OPERATION

The following paragraphs describe the basic method for making frequency and period measurements with the Model S1324A Counter. The self TEST for the instrument is included in Section 2.5 and should be performed prior to further operation. If the counter fails, reference should be made to Chapter 4 Maintenance and Calibration. Be sure not to obstruct the air intake on the rear panel.

3.5.1 FREQUENCY MEASUREMENTS

For making a frequency measurement the following steps should be followed:

a) Check LINE switch (Figure 3.2 Index 4) for appropriate line voltage setting and plug unit into a ground outlet.

b) Set 1MHz switch (Figure 3.2 Index 1) to INT. Set switch to EXT if using an external 1MHz standard connected to the 1MHz connector (Figure 3.2 Index 3).

c) Set STORAGE switch (Figure 3.2 Index 7) to ON. Set switch to OFF if visual display of cycling is desired.

d) Set "RANGE" switch (Figure 3.1 Index 2) to desired range.

e) Push INPUT LEVEL pushbutton (Figure 3.1 Index 3) for the highest level of attenuation which allows correct operation.

f) Push TEST pushbutton to off (Figure 3.1 Index 4).

g) Push FREQUENCY RES (Hz) pushbutton (Figure 3.1 Index 6) for desired resolution.

h) Turn DISPLAY/POWER OFF switch (Figure 3.1 Index 10) to on, and counterclockwise.

i) Connect signal to be measured to front panel "INPUT" connector (Figure 3.1 Index 1) and read

information on "DISPLAY" indicator (Figure 3.1 Index 9).

j) Push RESET pushbutton (Figure 3.1 Index 5).

For battery operation include the following step:

k) To read measurement information, push BATT. OPER. pushbutton (Figure 3.1 Index 8).

3.5.2 PERIOD MEASUREMENT

For making a period measurement the following steps should be followed:

a) Check LINE switch (Figure 3.2 Index 4) for appropriate line voltage setting and plug unit into a grounded outlet.

b) Set 1MHz switch (Figure 3.2 Index 1) to INT. Set switch to EXT if using an external 1MHz standard connector (Figure 3.2 Index 3).

c) Set STORAGE switch (Figure 3.2 Index 7) to ON. Set switch to OFF if visual display of cycling is desired.

d) Set "RANGE" switch (Figure 3.1 Index 2) to 50Hz - 25MHz.

e) Push INPUT LEVEL pushbutton (Figure 3.1 Index 3) for the highest level of attenuation which allows correct operation.

f) Push TEST pushbutton to off (Figure 3.1 Index 4).

g) Push PERIOD RES (μS) pushbutton (Figure 3.1 Index 7) for desired resolution.

h) Turn DISPLAY/POWER OFF switch (Figure 3.1 Index 10) to on.

i) Connect signal to be measured to front panel "INPUT" connector (Figure 3.1 Index 1) and read information on "DISPLAY" indicator (Figure 3.1 Index 9).

j) Push RESET pushbutton (Figure Index 5).

For battery operation include the following step:

k) To read measurement information, push BATT OPER. pushbutton (Figure 3.1 Index 8).

WARNING

HAZARDOUS ELECTRICAL POTENTIALS ARE PRESENT INSIDE THE EQUIPMENT CABINET. DO NOT REMOVE CABINET COVERS UNTIL LINE POWER IS DISCONNECTED.

Service personnel should be thoroughly familiar with the instrument prior to performing any maintenance procedures.

Chapter 4

MAINTENANCE AND CALIBRATION

4.1 FACTORY SERVICE

Whenever the instrument requires service, the nearest Motorola representative should be contacted. He can provide field service or arrange factory returns when necessary. Address all inquires on operation or application to your nearest Motorola Communications Division sales/service office listed in the front of this manual. Specify both model and complete serial number in all correspondence.

4.2 ROUTINE MAINTENANCE

A regular program for routine maintenance and inspection every five or six months is recommended for this counter (the oscillator may require calibration at more frequent intervals). As part of these regular procedures, the instrument should be checked in the following manner:

a. Disconnect ac power and loosen the cover by removing the two screws from the top panel.
b. Make a thorough inspection of all wiring and cables. Check for frayed, loose, or burned wires.
c. Check for physical integrity of all components. Look for burning or cracking, loose solder connections, leakage of insulation compounds, and general physical damage. If a printed circuit board contains integrated circuit packages, ensure that all packages are firmly mounted. Never unnecessarily remove or replace a circuit package.
d. Check all front panel switches and controls for loose or broken terminals, loose or sticking shafts, etc.
e. If the internal panel surfaces and components have an excessive amount of dust deposited on them, use a soft brush and low-pressure stream of air to remove the foreign material.

CAUTION

Do not clean PC boards or small internal components with a stiff brush or solvents, since damage to the circuits may result. A high-powered vacuum cleaner device should not be used on small internal components.

f. Wipe the external surfaces of the instrument with a soft, damp cloth to remove dirt, fingerprints, and other foreign material.
g. Replace the cover and reconnect the ac power. Now perform the Operational Test Procedure (Section 4.5). If performance does not match or exceed the specifications listed in Chapter 1 of this manual, check the instrument in accordance with Section 4.6.

4.3 PRINTED-CIRCUIT BOARD REPAIR

To remove a part on a printed circuit board, cut the leads of the part near the lead holes. Using a low power (50 watts or less) soldering iron, apply heat sparingly to each cut lead. As soon as the solder melts, slip the lead from the

hole and clean the hole with a toothpick. Clean the board surfaces with isopropyl alcohol. Form the tinned leads of the replacement part and insert in cleaned holes, trimming leads to extend 1/16 inch beyond the back surface of the board. Only 63-37 solder with a maximum diameter of 1/16 inch should be used. Solder the leads to the board and use a hemostat, long-nosed pliers, or other heat sink on all leads of all semiconductor devices and quarter-watt resistors. Allow the soldered junction to cool before removing the heat sink.

4.4 PARTS LOCATION

Printed circuit board outline drawings, with each part located upon the drawing, appear in Chapter 6.

4.5 OPERATIONAL TEST PROCEDURE

4.5.1 TEST EQUIPMENT

The following equipment is recommended: Equivalent instruments are acceptable.

(1) Oscilloscope - Tektronix 581 and Type 82 Plug-in.
(2) 1 MHz frequency standard; one part in 10^{-10} short term.
(3) Signal Generator - H.P. 651.
(4) Signal Generator - H.P. 608C.
(5) Variable autotransformer - Superior UC 1M (to be used if line does not measure 115V rms).
(6) Digital Voltmeter - SD 9025.
(7) Signal Generator - H.P. 612A.
(8) RF Voltmeter - H.P. 411A.
(9) AC Voltmeter - H.P. 400D.

4.5.2 GENERAL REMARKS

When a test instrument is referred to in the procedure paragraphs, its reference number is listed in Paragraph 4.5.1 to avoid ambiguity.

Tolerances indicated are exclusive of expected commercial equipment tolerances.

All input sensitivity measurements are made with voltmeter (8) or (9) connected at the input, with the exception of the prescaler sensitivity checks.

4.5.3 FUNCTION CHECK, IN TEST

First, perform the test procedure in Section 2.5 before proceeding to the next paragraphs. If the unit fails, check out the appropriate board(s).

4.5.4 PRESCALER CHECK

Connect generators, H.P. 608C or 612A (4,7) to input. Set 25 - 525 MHz / 50 Hz - 25 MHz "RANGE" switch to 25 - 525 MHz. Check for proper operation at the following frequencies:

Freq.	Input Max.
25 MHz	50 mV
100 MHz	50 mV
200 MHz	50 mV
300 MHz	50 mV
480 MHz	50 mV
525 MHz	50 mV

4.5.5 PERIOD CHECK

Set switch to Period as indicated. Connect generator (3) to input.

For both PERIOD RES, 1 µS and 10^{-4} µS,

Freq.	Input	Max. Counts Error
1 kHz	100 mV	±3 counts

4.6 CALIBRATION

This section comprises the recommended calibration/alignment procedure. The instrument should be calibrated every 60 days, whenever a component is replaced, or after failing the Operational Test Procedure (Section 4.5) -- whichever occurs first. Calibration should be performed in the specified sequence since each step is dependent upon the preceding step. The test equipment used in this procedure will be referenced to its item number, in Section 4.5.1, to avoid ambiguity.

4.6.1 PRELIMINARY

Remove the cover from the unit. Check that line voltage is between 105 and 125 V rms or between 210 and 250 V rms, whichever is applicable. Connect the unit to line power. Rotate DISPLAY/POWER switch to ON.

4.6.2 POWER SUPPLY ADJUSTMENT

a. With DVM (6), monitor Pin U, 17 of connector J6, +230 V bus. DVM should read +230±20V dc. If it does not, troubleshoot +230V supply and replace faulty component(s). With oscilloscope (1), check J6 Pin U,17 for ripple of less than 5 volts.

b. With DVM (6), monitor Pin 11,M of connector J6, +15V bus. DVM should read +15±1.5V dc. With oscilloscope (1), check J6 Pin 11, M for ripple of less than 20 mV. If supply voltage or ripple is incorrect, troubleshoot +15V supply and replace faulty component(s).

c. With DVM (6), monitor J6 pin 12,N for -15±1.5V dc. With oscilloscope (1), check J6 Pin 12,N for ripple of less then 20 mV. If a discrepancy exists, troubleshoot -15V supply and replace faulty component(s).

d. With DVM (6), monitor J6 Pin 10,L. Adjust R24 (Power Supply Board) for +5V±10 mV dc at J6 Pin 10,L. With oscilloscope (1), check J6 Pin 10,L for 20 mV or less of ripple. If supply voltage or ripple is incorrect, troubleshoot +5 V supply and replace faulty component(s).

e. With DVM (6), monitor J6 Pin 13,P. Adjust R36 (Power Supply Board) for -5.2V±10 mV dc at J6 Pin 13,P. With oscilloscope (1), check J6 Pin 13,P for 20 mV or less of ripple. If a discrepancy exists, troubleshoot -5.2V supply and replace faulty component(s).

4.6.3 OSCILLATOR ADJUSTMENT

Push TEST pushbutton to on. Place 1 MHz INT-EXT switch to INT. With oscilloscope (1), triggered by the 1 MHz (2) frequency standard, monitor the 1 MHz IN-OUT BNC for a 2.5V peak-peak (minimum amplitude), 1 MHz rectangular wave. Set COARSE frequency adjustment (counter rear panel) to a position which results in a stationary waveform on scope. Set FINE frequency adjustment (optional oscillators) for the most stationary waveform

on the scope. Place 1 MHz INT-EXT switch to EXT. Oscilloscope should no longer display 1 MHz signal. Remove calibration equipment.

4.6.4 INPUT BUFFER & OVERLOAD PROTECTION

a. Connect generator (3) to input. Push PERIOD RES 1 μS pushbutton. Set output of generator (3) to 1 MHz at 500 mV.

b. Push INPUT LEVEL, LOW pushbutton. Set "RANGE" switch to 50 Hz - 25 MHz position.

c. Observe Pin S,15 of J3 with scope (1).

d. Decrease output of generator (3) while maintaining a symmetrical signal by adjusting R9 (board A3). Correct operation (a symmetrical output signal) should be possible at levels below 50 mV.

4.6.5 200 MHz AMPLIFIER AND DECADE ADJUSTMENT

a. Push FREQUENCY RES 0.1 Hz pushbutton. With DVM (6), observe junction of S1, S2, S3, and R4 on the 200 MHz Amplifier and Decade P.C. Board. Check for ≈0.4V at the junction.

b. Observe collector of Q1 with DVM (6) and adjust R5 (adjacent to R9 and C13) for 1.5 volts ±50 mV.

c. Push LOW INPUT LEVEL pushbutton. Adjust signal generator (4) for a 125 MHz (100 mV) output. Connect generator output to INPUT connector. RANGE switch to 50Hz to 25MHz.

d. With sampling scope (1), observe the junction of S1, S2, and S3 -- waveform should be quite similar to Waveform #1, Figure 4-1, (approx. 180 mV peak-to-peak swing about a zero volt dc level).

e. Observe the collector of Q1 with sampling scope. Waveform 2, Figure 4-1, should be displayed.

f. Observe emitter of Q5 with sampling scope. Waveform 3, Figure 4-1, should be displayed.

NOTE: A slight adjustment of R5 may be necessary.

g. Monitor, with sampling scope, the collector of Q7. Adjust R23 for Waveform 4, Figure 4-1.

h. With sampling scope, monitor Q18 emitter. Waveform 5, Figure 4-1, should be observed on scope's display (Binary should be dividing by two).

i. With sampling scope, monitor Q13 collector for Waveform 6, Figure 4-1, indication. If necessary adjust the value of R53 (Rxxx).

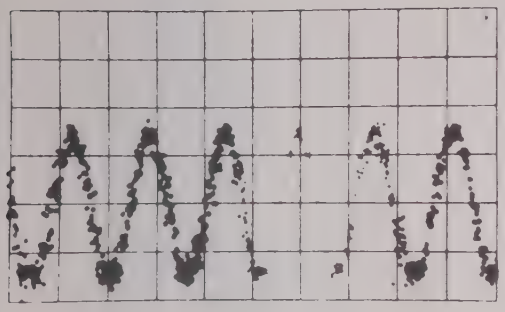
NOTE: The positive peak must be within 400 mV of ground.

j. Monitor emitter Q18, again, with sampling scope. Waveform 5, Figure 4-1, should still be observed. If not, re-adjust R23.

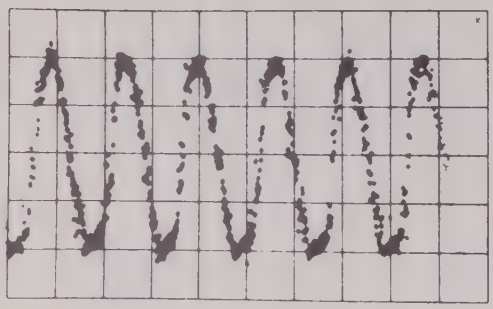
k. With oscilloscope (1), monitor Pin W for a 12.5 MHz signal approximately 2.5 volts in amplitude.

NOTE: This waveform should be the BCD "8" Bit.

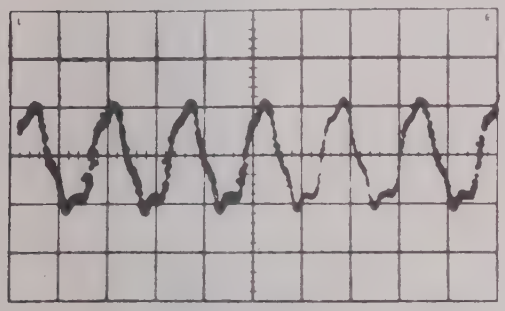
l. Place FREQ. RES. to 10 Hz position and observe counter display indication of 125.00000MHz Gradually decrease the input signal amplitude



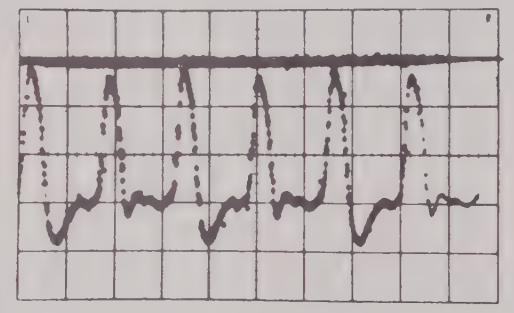
Waveform 1, Amplifier Input (125 MHz, 100 mV rms applied). Monitor R2 and R4 junction. Scope Settings: HORIZ, 5 nsec/cm and VERT, 50 mV/cm. Zero volts dc level.



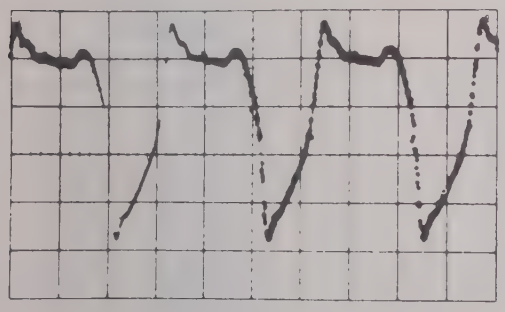
Waveform 2, Amplifier Output. Monitor Q1 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 100 mV/cm. AC coupled. 1.55 V dc level.



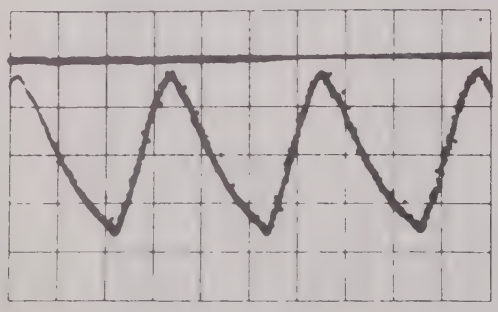
Waveform 3, Schmitt Trigger Output. Monitor Q5 emitter. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. AC coupled.



Waveform 4, Pulse Shaper. Monitor Q7 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. DC coupled. Horizontal line is zero reference.



Waveform 5, Binary Output Emitter Follower. Monitor Q18 emitter. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. AC coupled.



Waveform 6, Binary Buffer. Monitor Q15 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 1 V/cm. DC coupled. 0 reference at top.

Figure 4-1 Waveforms

from signal generator (4) while simultaneously adjusting R5 for best sensitivity-- 50 mV or less.

m. Disconnect all calibration equipment.

4.6.6 500 MHz PRESCALER ADJUSTMENT

a. Initial Adjustments (no input applied).

1) Set potentiometers R22 and R37 (prescaler P.C. Board) to mid-range.

2) Monitor Test Point F (Prescaler) with DVM (6). Adjust R25 (Prescaler Board) for -.530 volts dc. Remove DVM.

b. Preliminary Checks

1) With the signal generator (4), apply a 100 MHz (100 mV rms) signal to the input -- RANGE switch to 25-525 MHz and input signal to BNC connector. With sampling scope (1), monitor Test Point E (Prescaler) and adjust R22 for signal illustrated by Waveform 5, Figure 4-2.

2) With the sampling scope, monitor Test Point H (Prescaler) and adjust R25 for signal as illustrated by Waveform 6, Figure 4-2.

3) Monitor, with sampling scope, Test Point J (Prescaler) and adjust R25 for signal as illustrated by Waveform 7, Figure 4-2.

4) Monitor, with sampling scope, output Pin Y (Prescaler) for a correct divide-by-four signal -- as indicated by Waveform 8, Figure 4-2. Remove calibration equipment.

c. First Binary Calibration

1) Connect DVM (6) to Test Point F.

2) Apply, with signal generator (7), a 500 MHz (500 mV rms) signal to the INPUT connector. Adjust R25 for LOW voltage limit of operation -- indicated by a divide-by-four signal at test point Pin K (Use sampling scope).

NOTE: Beyond its HIGH and LOW input voltage operating limits, the Prescaler will divide the input signal by a factor other than four. Record voltage (LOW limit) at Pin F.

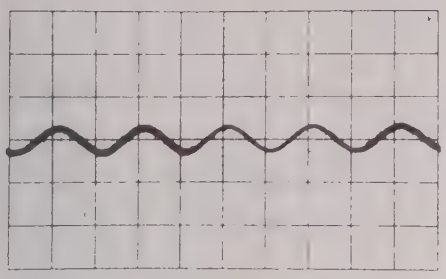
3) Adjust R25 for HIGH voltage limit of operation as indicated by the divide-by-four signal test point Pin K. Record voltage (HIGH limit) at Pin F.

4) Repeat Steps 2 and 3 using Item (4) and Item (7) (signal generators) to generate input signals of 200 MHz, 100 MHz, and 10 MHz respectively.

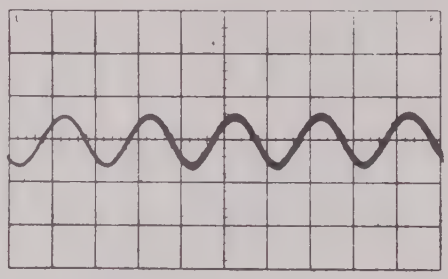
SAMPLE RECORDINGS
TEST POINT F

	HIGH	LOW
10 MHz	.553	.480
100 MHz	.570	.483
200 MHz	.594	.494
500 MHz	.614	.515

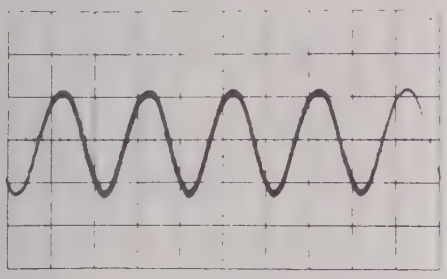
5) Voltage readings at each frequency indicate the window of operation for the binary at that particular frequency. To obtain the overall window of operation and the "voltage set



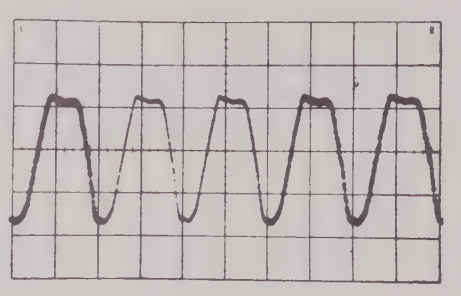
Waveform 1, Input (100 MHz, 100 mv rms [illegible] Settings: HORIZ, 5 nsec/cm and VERT, 500 mV/cm.



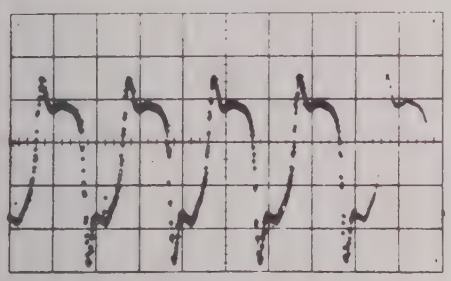
Waveform 2, Q1 Collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 500 mV/cm.



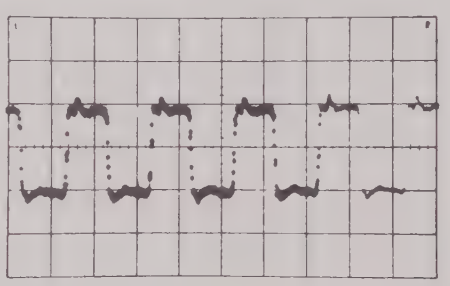
Waveform 3, Q2 Collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 500 mV/cm.



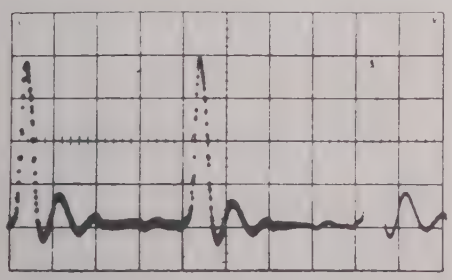
Waveform 4, Q3 Collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 500 mV/cm.



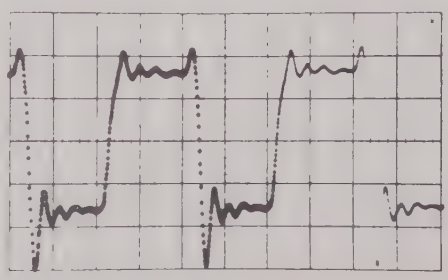
Waveform 5, CRT Cathode. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm.



Waveform 6, Q4 Base. Scope Settings: HORIZ, 10 nsec/cm and VERT, 100 mV/cm.



Waveform 7, Q6 Collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm.



Waveform 8, Pin Y into 50Ω Load. Scope Settings: HORIZ, 10 nsec/cm and VERT, 100 mV/cm.

Figure 4-2 Waveforms

point" at Pin F, compute the difference between the maximum LOW LIMIT voltage reading and the minimum HIGH LIMIT voltage reading (see Sample Recordings Test Point F):

$$\begin{array}{r} .553 \\ -.515 \\ \hline .038 \end{array} \Big/ .038/2 = .019 \qquad \begin{array}{r} .515 \\ +.019 \\ \hline .534 \end{array} = \text{Voltage Set Point}$$

The difference is divided by two and added to the maximum LOW LIMIT reading to obtain the "voltage set point" Pin F.

d. Final Adjustments

1) Alternately apply a 500 MHz signal and a 10 MHz signal with signal generators (4) and (7) to the INPUT connector. Monitor counter DISPLAY and adjust R22 (Prescaler) for best common sensitivity setting at both frequencies.

2) With signal generator (7), apply a 350 MHz signal to INPUT connector. Monitor counter DISPLAY and adjust R37 (Prescaler) for most stable operation.

3) Remove calibration equipment. The counter is now fully calibrated and should be ready for use.

e. Troubleshooting

Waveforms 2, 3, and 4 (Figure 4-2) are provided to illustrate the gain relationships in the wide-band amplifier. To check amplifier performance, apply a 100 MHz, 100 mV rms signal to the 525 MHz INPUT. (RANGE switch still in 525 MHz position) and observe the signal slopes with the sampling scope (1), at Prescaler test point Pins B, C, and D.

Chapter 5

CIRCUIT DESCRIPTIONS

5.1 INTRODUCTION

The following sections describe,in detail, the circuits of Model S1324A. The following schematics are described:

Power Supply & 1 MHz Shaper
500 MHz Prescaler
200 MHz Amp. & Decade
Control and Reset
Input Buffer & Overload Protection
100 MHz 8-Digit Readout

5.2 POWER SUPPLY & 1 MHz SHAPER P.C. ASSEMBLY (Page 6-7)

The power supply converts ac line power (115 or 230 Vac) to the various dc voltages (+225, +15, +5 and -5.2) required by the measurement circuitry. Power source conversion is easily achieved by changing the position of the AC LINE switch (S5) and the LINE FUSE (F1) value.

Primary (ac) power is directed by the line cord, the POWER ON-OFF switch, and the 115-230V switch to the primary windings of power transformer T1. The air circulating-fan (B1) receives its power via T1 primary winding 1-3. The T1 secondary windings transform the primary power to the following voltages: Winding 5-6 produces 170V rms, center-tapped winding 7-9 produces 35V rms, and center-tapped winding 10-12 produces 15.6V rms.

+225V Supply: The 170V rms is applied to a fullwave bridge rectifier, CR5 through CR8, and filtered by capacitor C11.

+15 and -15V Supplies: 35V rms is routed to a dual-fullwave rectifier, CR9 through CR12. The outputs (approximately 20V) are sent directly to the collectors of series regulators Q2 and Q1 -- the + and - regulators, respectively. R27 and CR15 appropriately bias the base of Q2 to produce a regulated +15V on the emitter of Q2. C9 is the associated filter capacitor. The -15V supply operates in a like manner with filter capacitor C10, R28, and CR16.

+5, -5.2V Supplies: The 15.6V rms is sent to dual-fullwave rectifier CR1, CR2, CR3, and CR4. Approximately 9V is then applied to the collectors of two sets of cascaded (for current gain) emitter followers (Q3 and Q4 +5V supply, and Q5 -5.2V supply). Each cascaded emitter follower is current supplied by a constant current source (Q8 for +5V and Q11 for -5V) and each 5V supply is precisely regulated by a series regulator transistor (Q7 for +5V and Q9 for -5.2V). R24 (+5V ADJ) and R36 (-5.2V ADJ) allow manual control of the regulator transistor (Q8 and Q11) outputs.

5.3 500 MHz PRESCALER P.C. ASSEMBLY (Page 6-9)

The functional sections of this board are: the input limiter and broad-band amplifier, the tunnel diode binary, the shaping circuitry, the transistor binary, and the time base expander. The amplifier and shaper arrangement used with this board ensures maximum stability of high frequency performance while the use of tunnel diodes permits the required high-speed switching.

5.3.1 Input Limiter

This circuit operates as a balanced bridge with the voltage across CR5 and

and CR6 following the input across resistor R1, R2, R3, R4, R5, and R6.

The positive and negative limiting levels are set by the supply voltages and the size of the resistors, R7 and R8. For the values indicated, the output is limited to approximately 1.2 volts. When positive limiting occurs, CR2 and CR3 conduct; CR1 and CR4 block. When negative limiting occurs, CR1 and CR4 conduct; CR2 and CR3 block. The output of the limiter is applied to the first stage of the broad-band amplifier. Transistors Q1, Q2, and Q3 and their associated circuit components form this 25 MHz to 500 MHz amplifier.

5.3.2 Tunnel Diode Binary

The output of the broad-band amplifier is coupled by C8 and L14 to tunnel diode shaper CR7. R22 is the level adjustment for the shaper. The input signal is further shaped by tunnel diode shaper CR8 before being applied to the input of the tunnel diode binary, CR10 and CR9. Q4 inverts and amplifies the binary output (input frequency divided by two).

5.3.3 Shaping Circuits

CR11, a tunnel shaper, accepts the output of the tunnel diode binary, differentiates it, and routes it to the differential amplifier, Q6 and Q7. The output of Q7 triggers the flip-flop (Q9 and Q10). Q8 and Q11 are the flip-flop output amplifiers. The output signal (Pin X of the Prescaler Board) is a rectangular wave approximately 5 volts in amplitude whose frequency is equal to the Prescaler input signal frequency divided by four.

5.3.4 Time Base Expander

This circuit comprises U2, a dual J/K master-slave flip-flop, and U1, a quadruple dual-input Nand gate. Because the Prescaler divides the input by four, the gate time (measurement interval) must be multiplied by four in order to achieve a direct display reading of the input frequency.

U2's external circuitry ensures that four consecutive selected (FUNCTION switch S1) time base gates applied to the input of U2 (Pin 5) result in one expanded (by 4) time base gate at U2's output (Pin 12). U1, essentially, controls the distribution of the expanded time base gate. If the RANGE switch is placed in the prescale position, Nand gate U1A is enabled (via inverted U1D and a ground on the 200 MHz Amplifier and Decade Board). The expanded gate is sent to the Control and Reset start and stop lines (when the switch is in Freq. position) via output Pin U (Prescaler) of the expander. At this same time Nand gate U1C is disabled.

When the RANGE switch is put in the 50 Hz to 25 MHz input position, U1C is enabled and U1A is disabled (via inverter U1C and CR16). So, the selected time base gate input, at Prescaler Pin T, is simply routed through inverter U1B and enabled U1C to the Prescaler's time base output Pin U. The expanded time base gate is blocked by disabled U1A.

5.4 200 MHz AMP & DECADE P.C. ASSEMBLY (Page 6-11)

The 200 MHz Amplifier and Decade Board is composed of a switching and a signal-routing circuit, an amplifier-shaper

circuit, and a decade counting circuit.

The switching and signal routing circuit contains (as circuit components) three relays, three diodes (CR6, 7, and 8), current control transistor Q17, and signal routing U9. If the RANGE switch is in the 50Hz - 25MHz position, L1 closes swinger S1 (Pin C is connected to Pin 7, Q17 is conducting, so L1 has a path from ground to +15 volts) and the Prescaler input signal is fed to the base of amplifier Q1. The 25 - 525MHz input position pulls in L2 in a similar manner. L3 receives the ground path necessary to close swinger S3 from Pin H which is grounded in all PERIOD positions of the switch.

Q1 of the amplifier and shaper circuit amplifies the input signal on its base. The amplified signal passes through emitter follower Q2, is shaped by a Schmitt trigger (Q3 and Q4), and passes through another emitter follower (Q5) before arriving at the collector of Q6.

At this point the decade counting circuit becomes important. If the Count Gate U2B (Control and Reset Board) is disabled (closed), gate-controlled transistor Q15 conducts, Q6 turns on and shunts tunnel diode shaper CR2. The signal that had been on the collector of Q6 is shunted to +5 volts and destroyed.

If Count Gate U2B (Control and Reset Board) is enabled, the signal on the collector of Q6 will be applied to and shaped by CR2, amplified by the differential amplifier (Q7 and Q8), and sent to the emitters of Q10 and Q11 to trigger the "1" binary. This trigger signal is approximately +500 mV in amplitude and 2 nanoseconds in duration.

The "1" binary consists of a reset amplifier (Q9), two cross-coupling elements (CR4 and CR5), the flip-flop (Q10 and Q11), an output emitter follower (Q18), and output amplifier Q13. The "1" binary is reset by the RESET signal (Pin V) on the base of Q9. The binary output signal, equal to one-half the trigger signal frequency, is routed via NOR gate U1 to a divide-by-five network (U2-U4). The outputs of this network are fed to level translators (U5-U7) which supply the least significant digit storage register (Display Board) with correct logic level binary coded decimal signals. The output of Pin W is the gated count divided by ten.

5.5 CONTROL AND RESET P.C. ASSEMBLY (Page 6-13)

This circuitry is the "heart" of the counter. All counter synchronization procedures are accomplished by this board -- the Count Gate controlling-signals (Gates) A and B, the RESET pulse, the TRANSFER pulse, are all produced by the Control and Reset circuitry. The Display Time Generator is also located on this assembly.

5.5.1 Count Gate Control

U3A and U3B comprise the "Start" and "Control" binaries of the instrument. The logic condition of these two binaries defines if the counting decades (accumulators) have information presented to them. These two binaries define the "Count Gate" condition - "Open" (counting), or "Closed" (not counting). The binaries are reset to a condition such that U3A, Pin 5 and U3B, Pin 9 are in a zero (low) state. The binaries are held in this state for a time determined by the "Inhibit" one-shot (U4C and U4D). U3B is additionally

controlled by the state of U3A due to the "D" line of U3B being controlled by the state of U3A Pin 5. As long as U3B Pin 12 is in the low (zero) state, the binary will not toggle. A positive-going change of state appearing coincidently or asynchronously at Pins F and E of J11 will toggle only U3A. This allows the output of U3B to go to a zero (low) state and to provide an "open" gate. Pin 12 of U3B now is in a "one" (high) state and is properly conditioned to [illegible] on Pin F (U3). That pulse toggles U3B producing a zero (low) state at Pin 8 of U3B, which produces a one (high) state at the [illegible] of U2B and a "closed" gate.

[illegible]

[illegible]-count signal is produced by [illegible] U2A. The output of this gate is positive until end-of-count (both Q outputs of [illegible] U3 are high).

[illegible]

The [illegible], via R5, is applied to the base of Q2. Q2 turns off and C3 [illegible] to charge (at a rate determined by R7 [C&R assembly], R6 [DISPLAY], the +15V supply, and C3) to the positive value which will fire unijunction transistor Q3. The negative 6V pulse generated by Q3 is applied to Reset one-shot U5A & B. The one-shot output (Reset pulse), 100 usec., 5 volt negative-[illegible] to saturated amplifier [illegible] C&R assembly) and to the Time Base Inhibit one-shot U4C & D. Depressing CLR also causes the Reset pulse to be generated.

5.5.4 Inhibit

The output of the Time Base Inhibit one-shot, approximately 55 msec, 5 volt negative-going pulse has two major functions. This output inhibits the time base, while it clears the Start-Stop Binary U3A & B. It also clears F.F. U3A via NOR gate U5C and inverter Q7, and clears F.F. U3B via NOR gate U4B and inverter U4A.

5.5.5 End of Count, Gate Light, Transfer

The EOC signal (via C8, R19, and CR4) is differentiated and applied to saturated amplifier Q6. When the STORAGE ON-OFF switch is in OFF, Pin S of the C&R assembly is grounded and Q6 is held off so all counting information is constantly being transferred to the readout. CR4 isolates this ground from the Reset and Start-Stop circuitry. U2C and D comprise the minimum gate-light-time one-shot. The output of NOR gate U2A is either the output of U2C and D or the length of time the measurement interval gate U2B is enabled -- whichever is longer. Q1 is the GATE LAMP driver. The "gate on" signal at Pin 14 of the C&R assembly is the start-stop counting signal.

5.5.6 Time Base

The circuit operates in the following manner. FUNCTION switch S1 picks [illegible] the selected signal to be scaled by some selected power of 10. U7-U13 form a chain of decades whose outputs are selected. The selected decade output is then routed, dependent on function, to the appropriate control point. The time base dividers are reset to a "9" condition and are held for a predetermined period of time to allow for clearing and settling after a reset has been initiated. When properly conditioned the instrument will start counting on the first input received after the "Inhibit T.B." time.

5.6 INPUT BUFFER & OVERLOAD PROTECTION P.C. ASSEMBLY (Page 6-15)

The input attenuated signal is fed to Q1 and Q2 which maintain a high input impedance. The signal is amplified at Q3 by a factor of 20. R9 is used to reduce this input signal and to optimize for best sensitivity. The output is then shaped by Schmitt trigger Q4 and Q5, and buffered by amplifier Q6.

From the Prescaler board overload detector circuit, Q7 senses the peak voltage of the rf input and provides a dc level to binary Q8 and Q9. When the input level exceeds a fixed amount, the binary toggles, de-activating Q10 and opening the input relay.

5.7 100 MHz 8-DIGIT P.C. ASSEMBLY (Page 6-17)

This circuit provides the numerical readout with decimal point location and is composed of two sections: an indicator logic section and a readout driver section.

5.7.1 Indicator Logic Section

This section provides the circuits necessary to count the output signal from the 200 MHz Amplifier and Decade Board Pin W and store the eight digits of the count during the GATE ON interval. The 200 MHz Amplifier and Decade Board count decade (the "1" binary and ":5" network), plus seven identical count decades (U18 - U24) and eight associated storage registers (U10 - U17), are cascaded to achieve this function. Each decade is essentially four flip-flops connected as a binary-coded-decimal counter. Each provides a ":10" output to trigger the next decade counter stage, and delivers its count at the end of the GATE ON interval to be stored until the next counting cycle. Each decade is reset to zero by the RESET pulse. When the TRANSFER signal occurs, the information present at the Data Inputs (Pins 2, 3, 6, and 7) of each storage register is transferred to the Q outputs (Pins 16, 9, 15, and 10), and remains there until the next TRANSFER pulse. The Q outputs are routed to the Readout and Driver Section.

5.7.2 Readout and Driver Section

This section converts the stored BCD information from the indicator logic section into 10-digit parallel-decimal form to drive the readout tubes. Eight identical BCD-Decimal decoder drivers (U2 - U9) and cold-cathode gas filled indicator tubes are used.

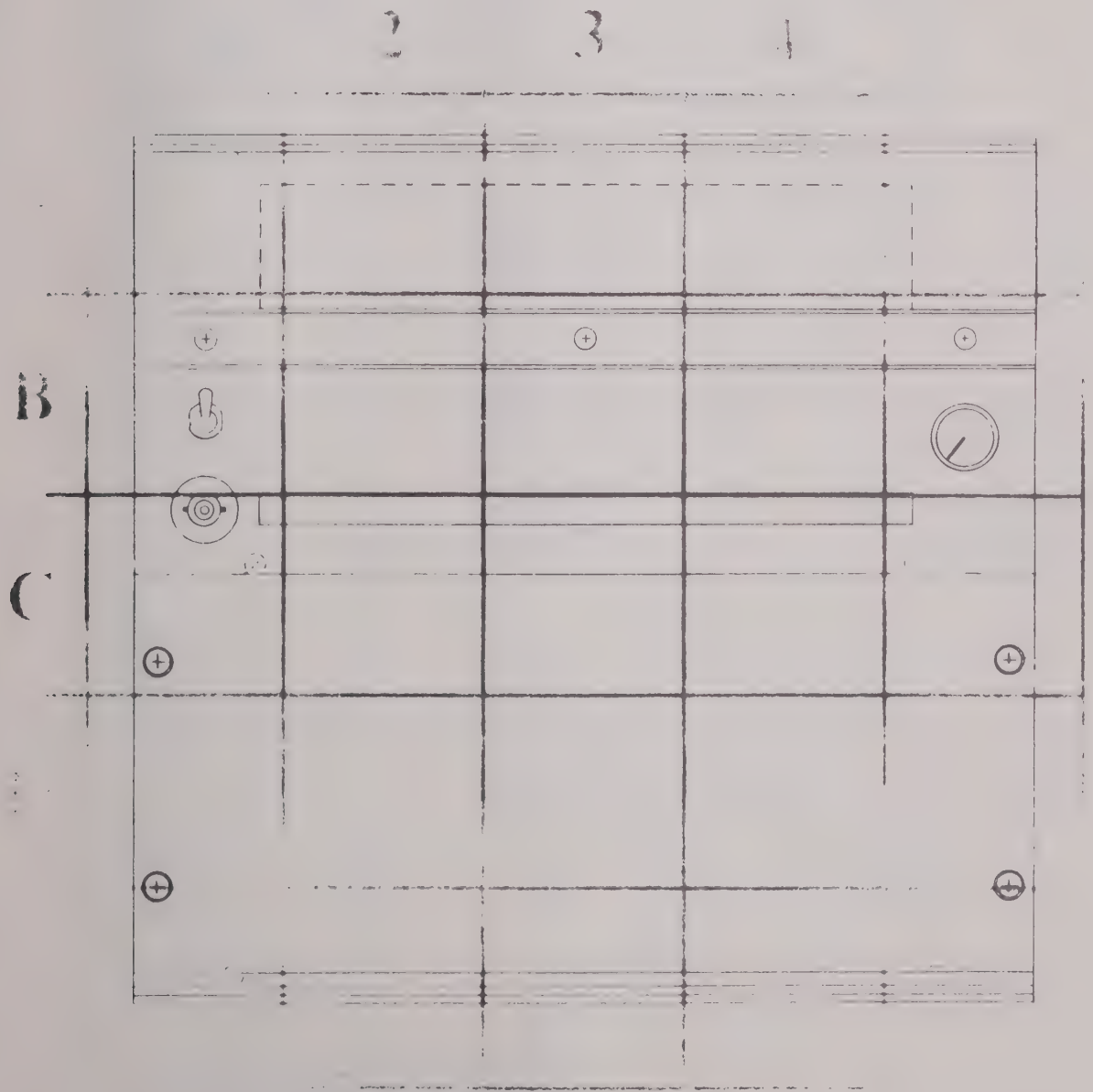
The BCD-Decimal decoder consists of TTL (transistor-transistor logic) circuits which select one of ten built-in decimal output drivers (high breakdown NPN transistors), which in turn, drives the readout tube. Decimal point position selection and drive is provided by a ground supplied at the FUNCTION switch. The automatic units-of-measure indicators operate in a like manner.

Chapter 6

DRAWINGS AND PARTS LOCATOR

6.1 INTRODUCTION

This chapter contains schematics, assemblies and parts lists for the Model S1324A counter. A locator index has been provided to simplify component location.



FRONT PANEL SUBASSEMBLY 1P84250C32

FRONT PANEL SUBASSEMBLY

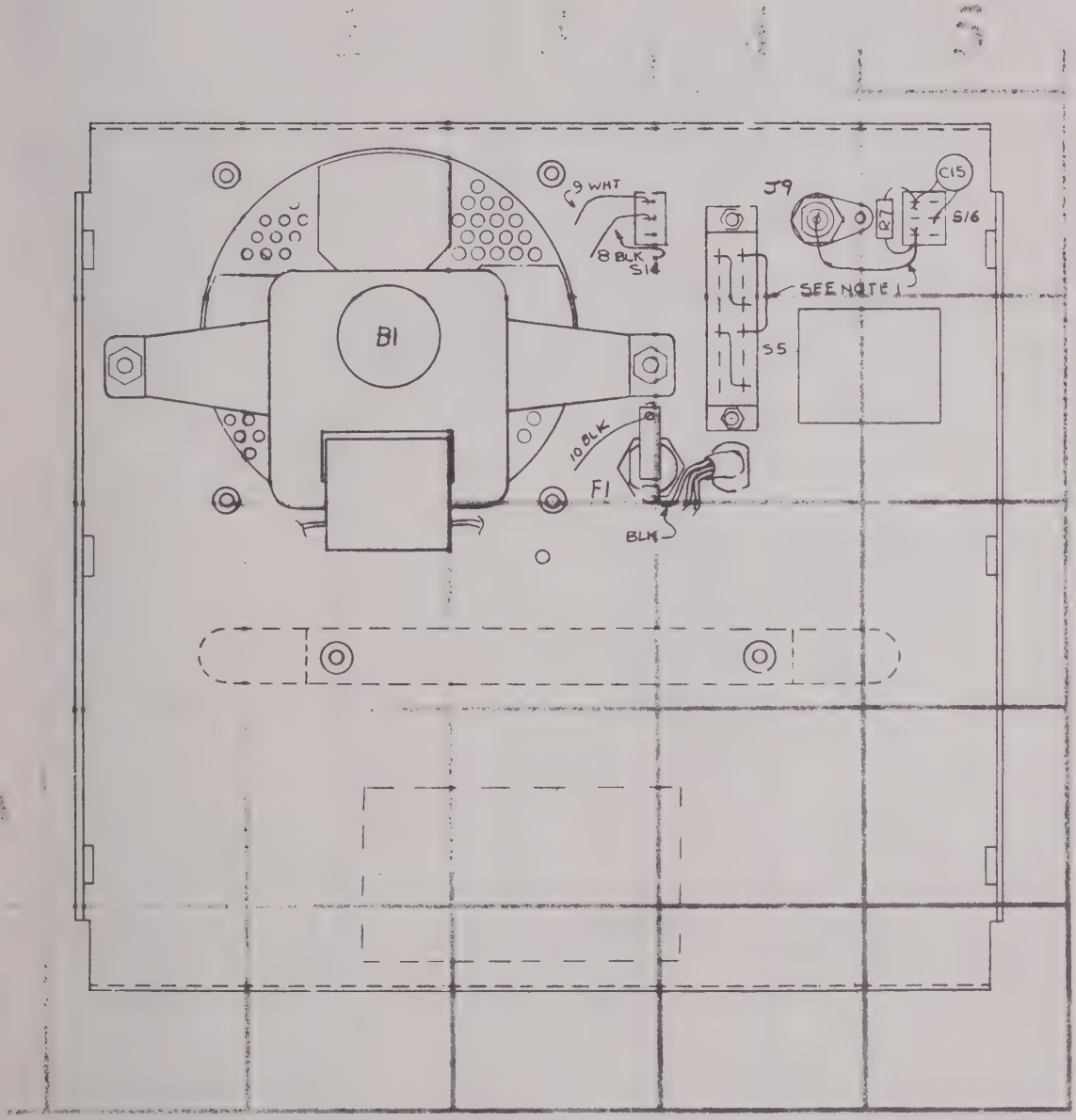
Ref.	Index	Motorola No.
J1	C1	28P84250C10
R6	B5	18P84309A22
S12	B1	40P84250
S13	B5	18P84309A22
Polaroid Filter	A1-5	61P84250C20
Decorative Panel	B1-5	64P84250C21
Knob	B5	36P84309A97
Front Cover Assembly		1P84250C30

REAR PANEL SUBASSEMBLY

Ref.	Index	Motorola No.
B1	B2	59P84250C09
C15	A5	21P84309A25
F1	B3	65P84309A98
J9	A4	28P84250C14
R7	A5	18P84250C32
S4	A3	40P84250C02
S5	B4	40P84250C01
S16	A5	40P84309A99
Line Cord	B4	30P84250C18
Fuse Holder	B3	65P84250C07
Fan Blade	A2	49P84250C08
Fan Cover	A2	15P84250C12
Fan Screen	A2	35P84250C11
Fan Filter	A2	64P84250C10

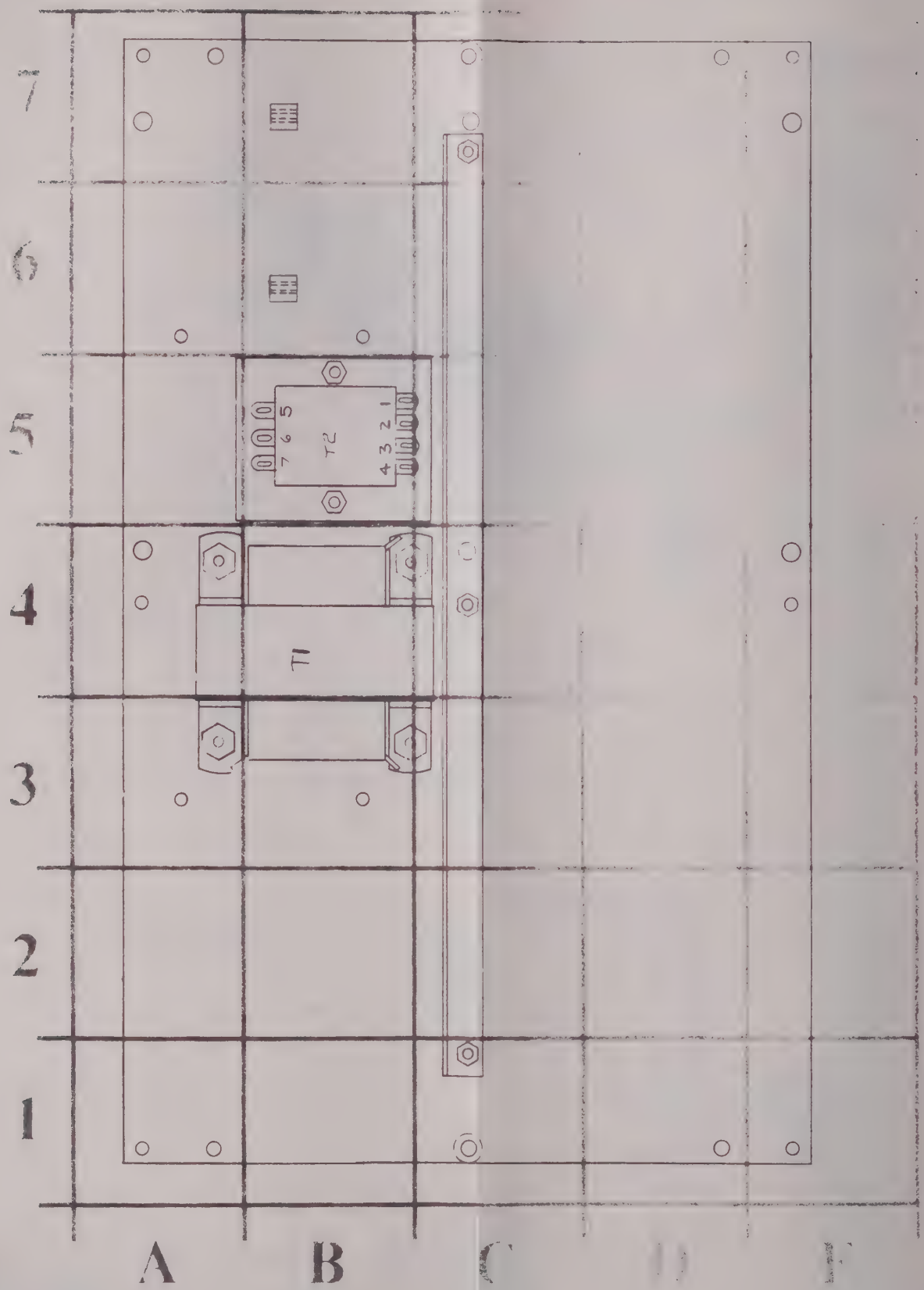
RIGHT GUSSET ASSEMBLY

Ref.	Index	Motorola No.
T1	B4	25P84309A85
T2	B5	25P84309A86



REAR PANEL SUBASSEMBLY 1P84250C33

S1324A-9-70



RIGHT GUSSET ASSEMBLY 1P84250C34

MOTHER BOARD P.C. ASSEMBLY 1P84250C23

MOTHER BOARD P.C. ASSEMBLY 1P84250C23

CAPACITORS

Ref.	Index	Motorola No.
C1	D7	21P84309A30
C2	D7	21P84309A40
C3	D7	21P84309A41
C4	D7	21P84309A42
C5		Not Used
C6	D7	21P84250C34
C7	D7	21P84309A44
C8	D7	21P84309A42
C9	D2	23P84309A45
C10	B2	23P84309A45
C11	B3	23P84309A46
C12	C2	23P84309A47
C13	B2	23P84309A45
C14	B5	21P84309A25
C15		Not Used
C16	B5	23P84309A48
C17	C2	23P84309A47

DIODES

CR1	B5	48P83698E06
CR2	B5	48P83698E06
CR3	B5	48P83698E06
CR4	B5	48P83698E06
CR5	B5	48D83461E12
CR6	A6	48P8369E06
CR7	A6	48P8369E06

TRANSISTORS

Ref.	Index	Motorola No.
Q1	B6	48R84302A70
Q2	B6	48P84309A70
Q3	C6	48P84309A70
Q4	C2	48P84309A70
Q5	B6	48R84302A70
Q6		Not Used
Q7		Not Used
Q8		Not Used
Q9		Not Used
Q10	B6	48P84309A70

CONNECTORS

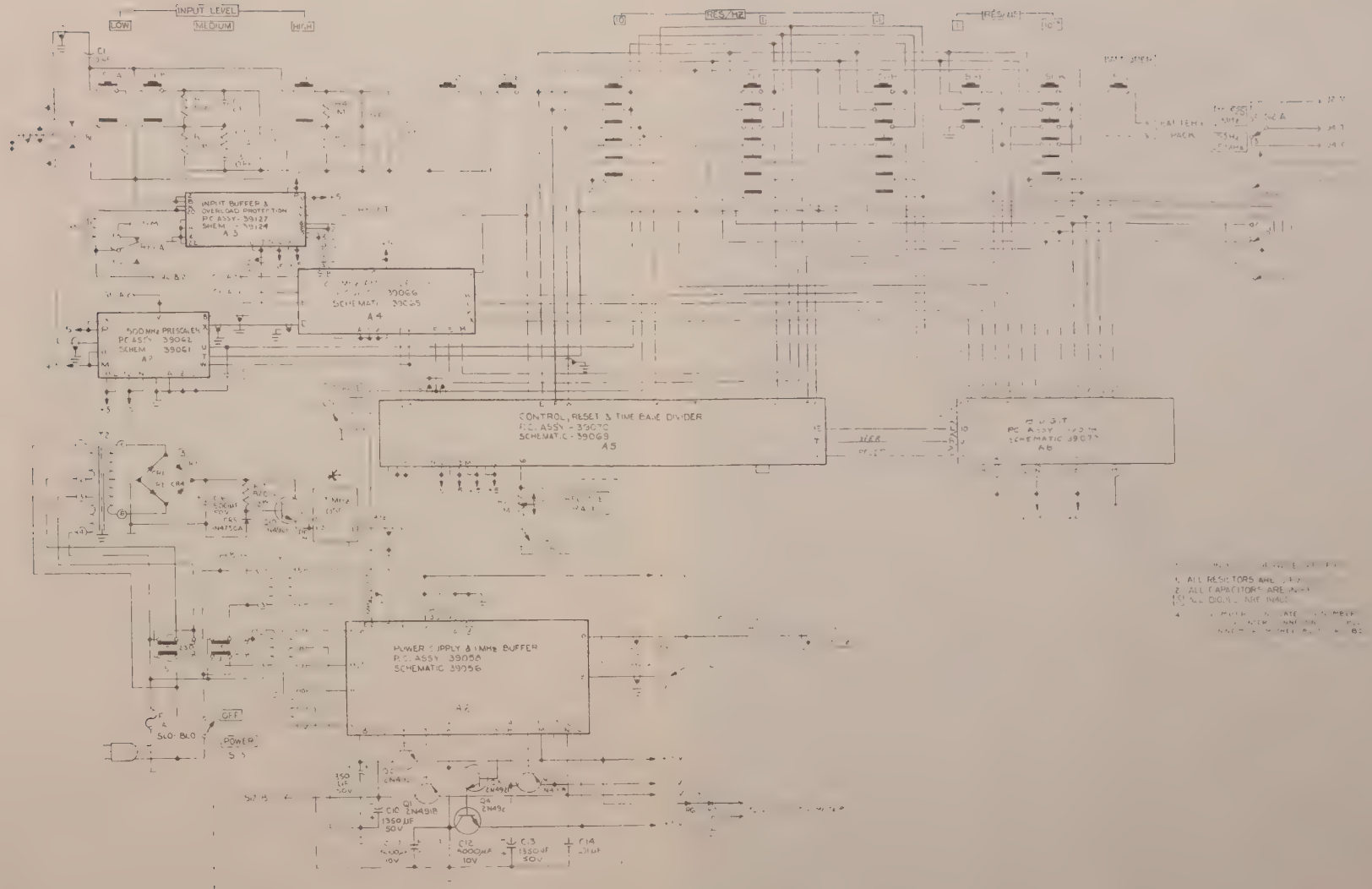
J1		Not Used
J2	E3	28P84250C13
J3	D3	28P84250C13
J4	D3	28P84250C13
J5	C3	28P84250C13
J6	C3	28P84250C13
J7	A6	28P84250C17

RESISTORS

R1	D7	6P84309A21
R2	D7	6S124A97
R3	D7	6S131525
R4	D7	6R129189
R5	D7	6R129668

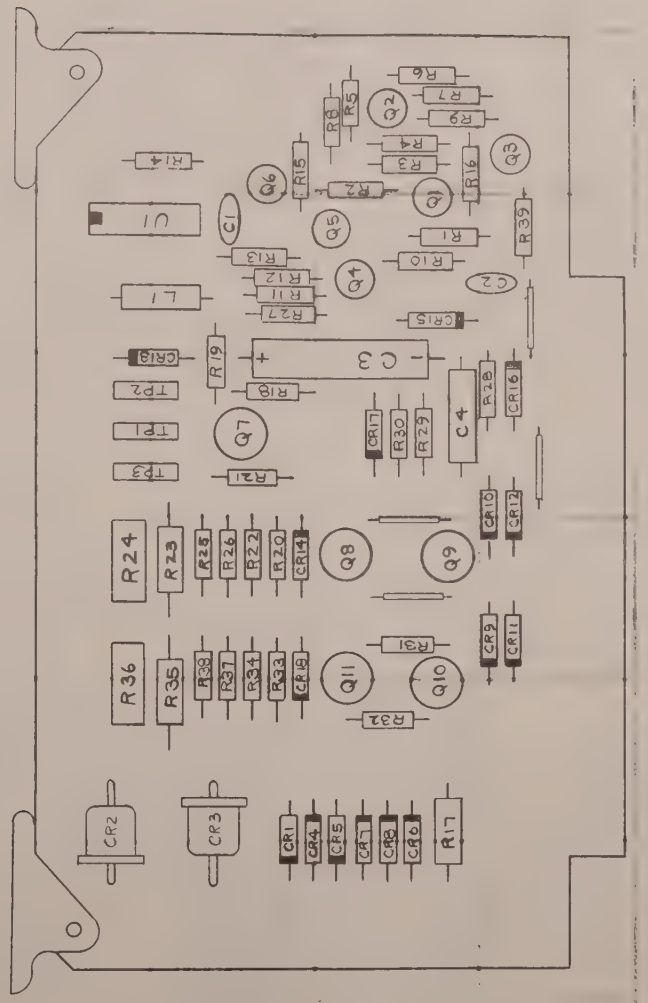
RESISTORS

Ref.	Index	Motorola No.
R6		Not Used
R7		Not Used
R8		Not Used
R9		Not Used
R10		Not Used
R11		Not Used
R12		Not Used
R13		Not Used
R14		Not Used
R15		Not Used
R16		Not Used
R17	B5	6K129818



S1324A-9-70

5 1 5 44 BLOCK DIAGRAM
5 1 F 4 2 L 0 2 3 2



POWER SUPPLY & 1MHz SHAPER P.C. ASSEMBLY 1P84250C22

POWER SUPPLY & 1MHz SHAPER
P.C. ASSEMBLY 1P84250C22

CAPACITORS

Ref.	Index	Motorola No.
C1	B5	21P84309A26
C2	D5	21P84309A49
C3	D4	23P84309A50
C4	D4	8P84309A51

INTEGRATED CIRCUIT

U1	B5	51P84309A72

DIODES

CR1	B1	48P83698E06
CR2	A2	48C82525G07
CR3	B2	48C82525G07
CR4	C2	48P83698E06
CR5	C2	48P83698E06
CR6	C2	48P83698E06
CR7	C2	48P83698E06
CR8	C2	48P83698E06
CR9	D3	48P83698E06
CR10	D4	48P83698E06
CR11	D3	48P83698E06
CR12	D4	48P83698E06
CR13	B4	48P83193A59
CR14	B3	48P83698E07
CR15	C5	48P83624E03
CR16	D4	48P83624E03
CR17	D4	48P83193A59
CR18	B3	48P83698E07

TRANSISTORS

Ref.	Index	Motorola No.
Q1	C5	48P84305A20
Q2	C6	48P84305A20
Q3	D6	48P84305A20
Q4	C5	48P84305A20
Q5	C5	48P84305A20
Q6	B6	48P84305A20
Q7	B4	48P83699E64
Q8	C3	48R84302A51
Q9	C3	48R84302A51
Q10	C3	48P83699E64
Q11	C3	48P83699E64

INDUCTOR

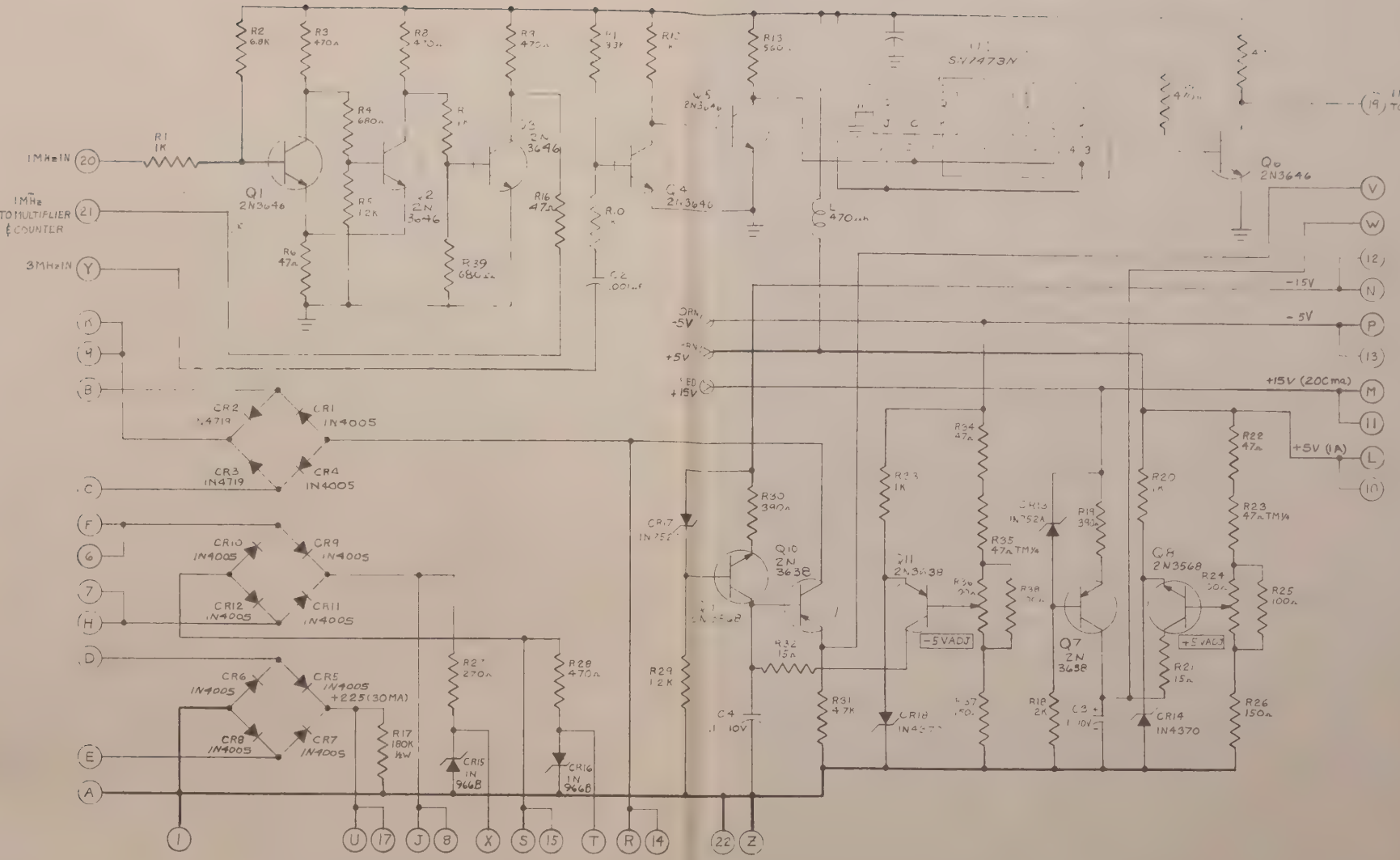
L1	B5	24P84309A91

RESISTORS

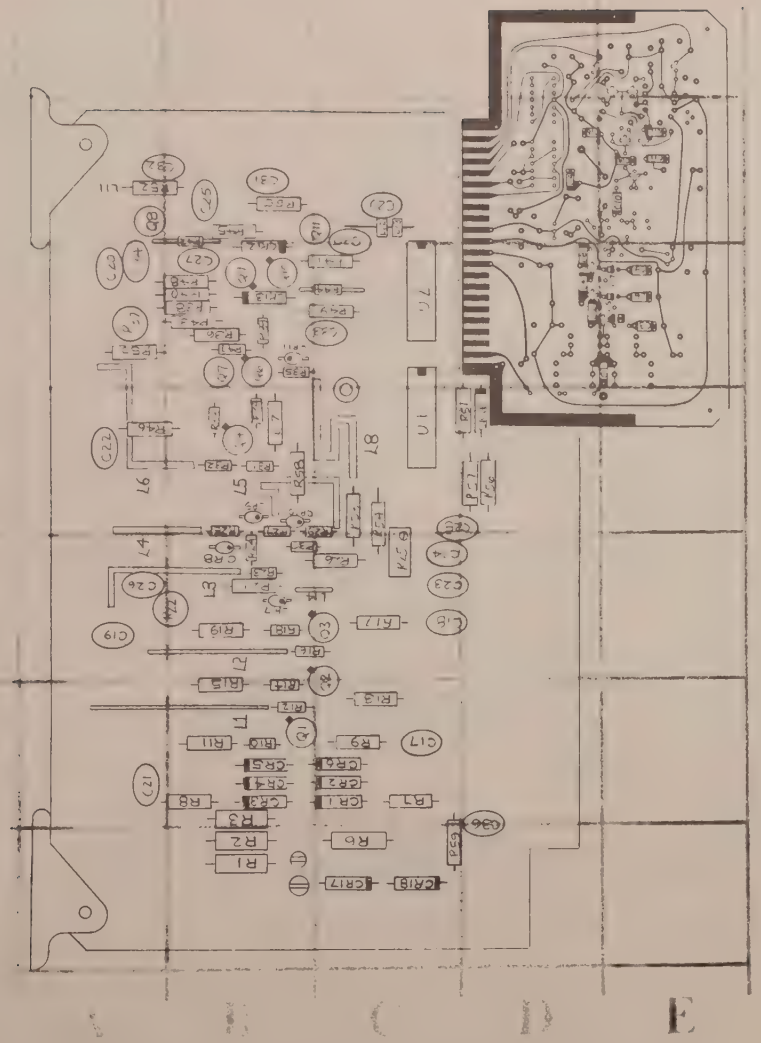
R1	C5	6R129805
R2	C6	6R129237
R3	C6	18P84250C32
R4	C6	6R129984
R5	C6	6R129708
R6	C6	6R131274
R7	C6	6R129805
R8	C6	18P84250C32
R9	C6	18P84250C32
R10	C5	6R129805

RESISTORS

Ref.	Index	Motorola No.
R11	B5	6K129526
R12	B5	6R129805
R13	B5	6R129776
R14	B6	18P84250C32
R15	B6	18P84250C32
R16	C6	6R131274
R17	C2	6R2061
R18	B4	6R129708
R19	B4	6S10053A14
R20	B3	6R129805
R21	B4	6P84309A18
R22	B3	6R131274
R23	B3	6P84309A19
R24	A3	18P84309A20
R25	B3	6K131524
R26	B3	6R131276
R27	B5	6R131525
R28	D4	18P84250C32
R29	D4	6R129708
R30	D4	6S10053A18
R31	C3	6R129669
R32	C2	6P84309A18
R33	B3	6R129805
R34	B3	6R131274
R35	B2	6P84309A19
R36	A2	18P84309A20
R37	B3	6R131276
R38	B3	6K131524
R39	D5	6R129984



POWER SUPPLY & 1MHz SHAPER
SCHEMATIC 73P84250C33



500MHz PRESCALER P.C. ASSEMBLY 1P84250C15

500MHz PRESCALER P.C. ASSEMBLY 1P84250

CAPACITORS		
Ref.	Index	Motorola No.
C1	D5	21P84309A23
C2	D5	21P84309A23
C3	E5	21P84309A23
C4	D5	21P84309A23
C5	E5	21P84309A24
C6	E5	21P84309A23
C7	E5	21P84309A24
C8	D5	21P84309A23
C9	E5	21P84309A23
C10	E6	21P84309A23
C11	E6	21P84309A23
C12	E6	21P84309A23
C13		Not Used
C14	D6	21P84309A23
C15	E6	21P84309A23
C16	D6	21P84309A23
C17	C2	21P84309A25
C18	C3	21P84309A25
C19	A3	21P84309A25
C20	A5	21P84309A25
C21	A2	21P84309A25
C22	A4	21P84309A25
C23	C3	21P84309A25
C24	C3	21P84309A26
C25	B6	21P84309A26
C26	A3	21P84309A26
C27	B5	21P84309A26
C28	C4	21P84309A26
C29	C6	21P84309A26
C30	C6	21P84309A26
C31	B6	21P84309A26
C32	A6	21P84309A26
C33	C5	21P84309A26
C34	A5	21P84309A26
C35		Not Used
C36	D2	21P84309A26

DIODES		
CR1	C2	48P84309A52
CR2	C2	48P84309A52
CR3	B2	48P84309A52
CR4	B2	48P84309A52
CR5	B2	48P84309A52
CR6	C2	48P84309A52
CR7	B3	48P84309A53
CR8	B3	48P84309A54
CR9	B4	Part of CR8
CR10	B4	Part of CR8
CR11	B5	48P84309A55
CR12	B5	48P84309A56
CR13	B5	48P84309A56

DIODES		
CR14		Not Used
CR15		Not Used
CR16	D4	48P84309A57
CR17	C1	48P84309A58
CR18	C1	48P84309A58

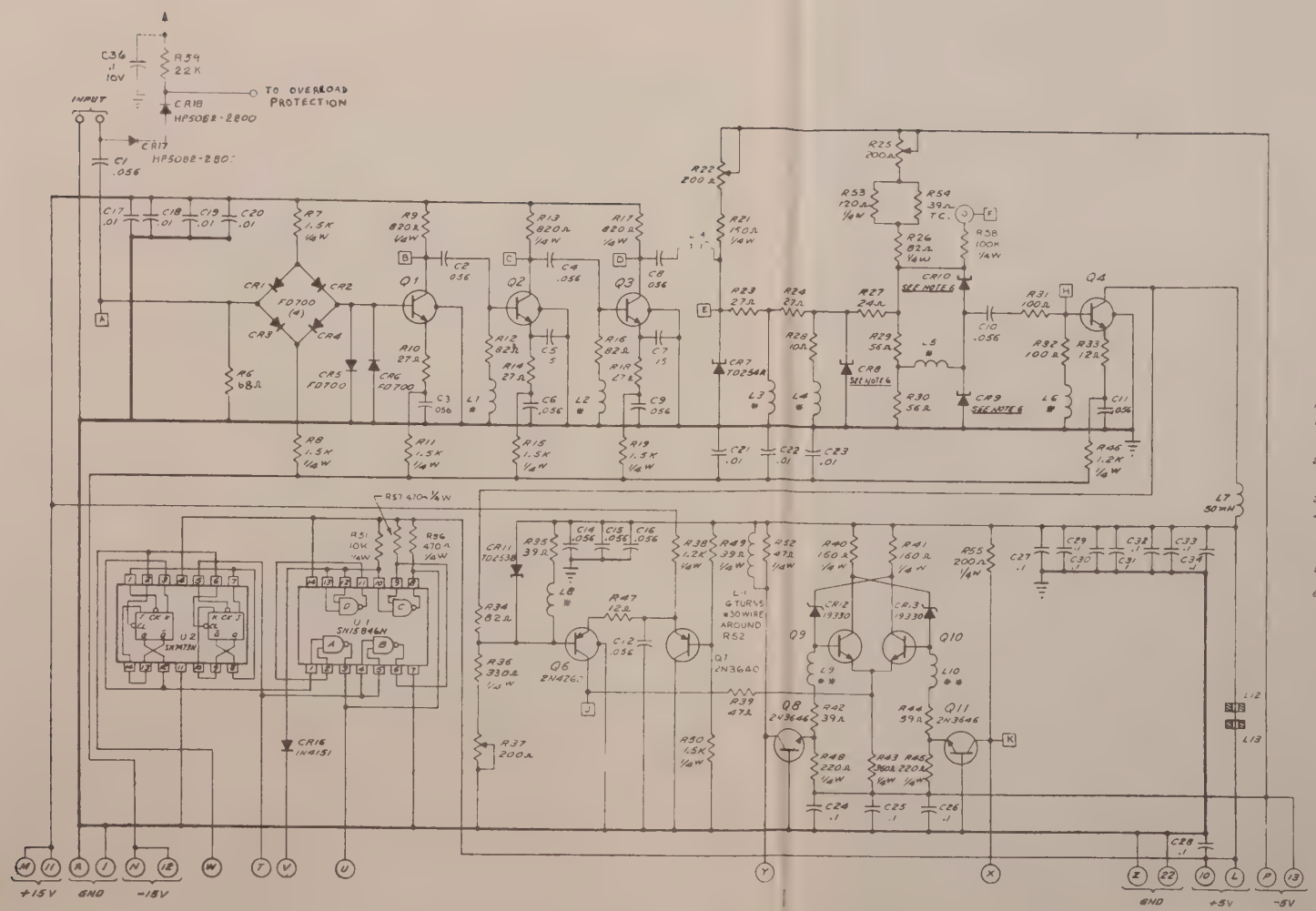
TRACE PATTERNS		
L1	B2	Trace Pattern
L2	B3	Trace Pattern
L3	B3	Trace Pattern
L4	A4	Trace Pattern
L5	B4	Trace Pattern
L6	A4	Trace Pattern
L7	B4	24P84309A87
L8	C4	Trace Pattern
L9		Part of R42
L10		Part of R44
L11	A6	51P84309A79
L12	C6	76P84309A92
L13	C6	76P84309A92
L14	B3	76P84309A92

TRANSISTORS		
Q1	B2	48P84309A61
Q2	C3	48P84309A61
Q3	C3	48P84309A61
Q4	B4	48P84309A61
Q5		Not Used
Q6	B5	48P84309A62
Q7	B5	48P84309A63
Q8	A6	48P84309A20
Q9	B5	48P84309A61
Q10	B5	48P84309A61
Q11	B6	48P84309A20

RESISTORS		
R1	B1	6R400804
R2	B1	6R400804
R3	B2	6R400804
R4	C1	6R400804
R5	C1	6R400804
R6	C2	6R400804
R7	C2	5K129681
R8	B2	6K129681
R9	C2	6K129818
R10	B2	6S185A11
R11	B2	6K129681
R12	B2	6S185A23
R13	C2	6K129818
R14	B2	6S185A11
R15	B2	6K129681

RESISTORS		
Ref.	Index	Motorola No.
R16	B3	6S185A23
R17	C3	6K129818
R18	B3	6S185A11
R19	B3	6K129681
R20		Not Used
R21	B3	6R131276
R22	A3	18P84309A06
R23	B3	6S185A11
R24	B3	6S185A11
R25	C3	18P84309A07
R26	C3	6S124A23
R27	B4	6S85A10
R28	B4	6S185A01
R29	B4	6S185A19
R30	B3	6S185A19
R31	B4	6S185A25
R32	B4	6S185A25
R33	B4	6S185A03
R34	B4	68185A23
R35	B5	6S185A15
R36	B5	6K129806
R37	A5	18P84309A06
R38	B5	6R129708
R39	B5	6S185A17
R40	B5	6P84309A08
R41	C5	6P84309A08
R42	B6	6S185A15
R43	B5	6S10053A44
R44	C5	6S185A15
R45	B6	6R131275
R46	A4	6R129708
R47	B5	6S185A03
R48	B5	6R131275
R49	C5	6P84309A09
R50	A5	6K129681
R51	D4	6R129668
R52	A6	Part of L11
R53	C4	6S10053A38
R54	C4	6P84309A10
R55	B6	6S124A32
R56	D4	18P84250C32
R57	D4	18P84250C32
R58	B4	6S124A97
R59	C1	6R129804

INTEGRATED CIRCUITS		
U1	C4	51P84309A71
U2	C5	51P84309A72



NOTE: EXCEPT AS NOTED.

1) RESISTORS:
POWER ----- 1/8 W.
TOL ------ 5%.

2) CAPACITORS:
VALUE ---- LESS THAN ONE IN μF.
" MORE " " " pF.

3) TRANSISTORS ARE 2N5179.

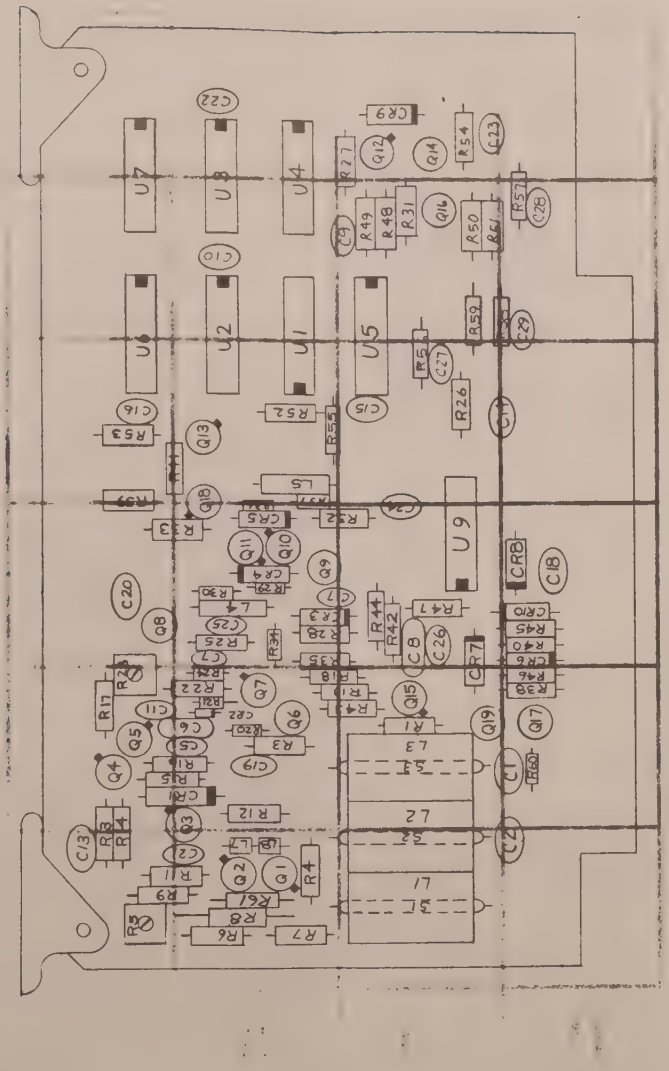
4) * - INDICATED CHOKES ARE PART OF PC PATTERN.
* - INDICATED CHOKES ARE RESISTOR MODULE.
L12 & L13 ARE FERRITE BEADS.
L14 #26 SLEEVED WIRE

5) A - TEST POINTS REFERRED TO IN ALIGNMENT PROCEEDURE

6) CR8, CR9, CR10 MATCHED SET TD 2538 DIODES PER. SPEC. 27960

500MHz PRESCALER
SCHEMATIC 73P84250C34

S1324A-9-70



200MHz AMP & DECADE P.C. ASSEMBLY 1P84250C31

200MHz AMP & DECADE P.C. ASSEMBLY 1P84250C31

CAPACITORS		
Ref	Index	Motorola No.
C1	D2	21P84309A25
C2	D1	21P84309A25
C3		Not Used
C4		Not Used
C5	B2	21P84309A25
C6	B2	21P84309A27
C7	B3	21P84309A25
C8	C3	21P84309A28
C9	C5	21P84309A25
C10	B5	21P84309A25
C11	A2	21P84309A25
C12		Not Used
C13	A1	8P84309A29
C14	C4	8P84309A29
C15	C4	8P84309A29
C16	A4	8P84309A29
C17	B3	8P84309A29
C18	D3	8P84309A29
C19	B2	8P84309A29
C20	A3	8P84309A29
C21	B1	8P84309A29
C22	B6	8P84309A29
C23	C6	8P84309A29
C24	C3	8P84309A29
C25	B3	21P84309A25
C26	C3	Sel. Capacitor
C27	C4	21P84309A25
C28	D5	21P84309A25
C29	D5	21P84309A25

DIODES		
CR1	B2	48P84309A56
CR2	B2	48P84309A59
CR3	B3	48P84309A56
CR4	B3	48P84309A56
CR5	B3	48P84309A56
CR6	D3	48P84309A57
CR7	C3	48P84309A57
CR8	D3	48P84309A57
CR9	C6	21P84309A25
CR10	D3	48P84309A57

INDUCTORS		
L1	C1	24P84309A88
L2	C2	24P84309A88
L3	C2	24P84309A88
L4	B3	24P84309A89
L5	B4	24P84309A89
L6		Not Used
L7	B1	76P84309A92
L8	B1	76P84309A92

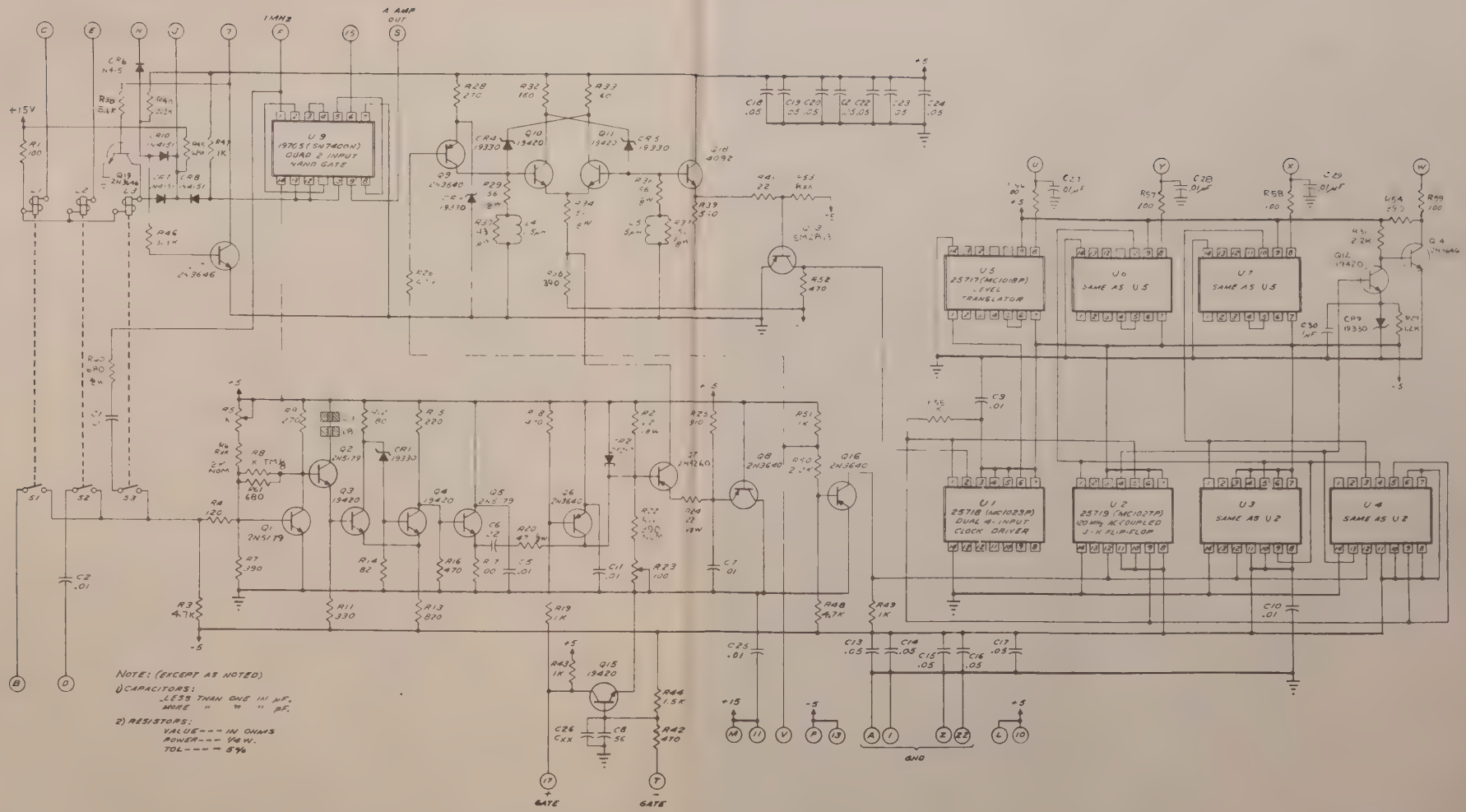
INTEGRATED CIRCUITS		
Ref.	Index	Motorola No.
U1	B4	51P84309A82
U2	B4	51P84309A83
U3	B5	51P84309A83
U4	B5	51P84309A83
U5	C4	51P84309A84
U6	A4	51P84309A84
U7	A5	51P84309A84
U8		Not Used
U9	C3	51P84309A73

TRANSISTORS		
Q1	B1	48P84309A61
Q2	B1	48P84309A61
Q3	A2	48P84309A64
Q4	A2	48P84309A64
Q5	A2	48P84309A61
Q6	B2	48P84309A63
Q7	B2	48P84309A62
Q8	A3	48P84309A63
Q9	B3	48P84309A63
Q10	B3	48P84309A64
Q11	B3	48P84309A64
Q12	C6	48P84309A64
Q13	B4	48P84309A65
Q14	C6	48P84305A20
Q15	C2	48P84309A64
Q16	C5	48P84309A63
Q17	D2	48P84305A20
Q18	B4	48P84309A66
Q19	C2	48P84305A20

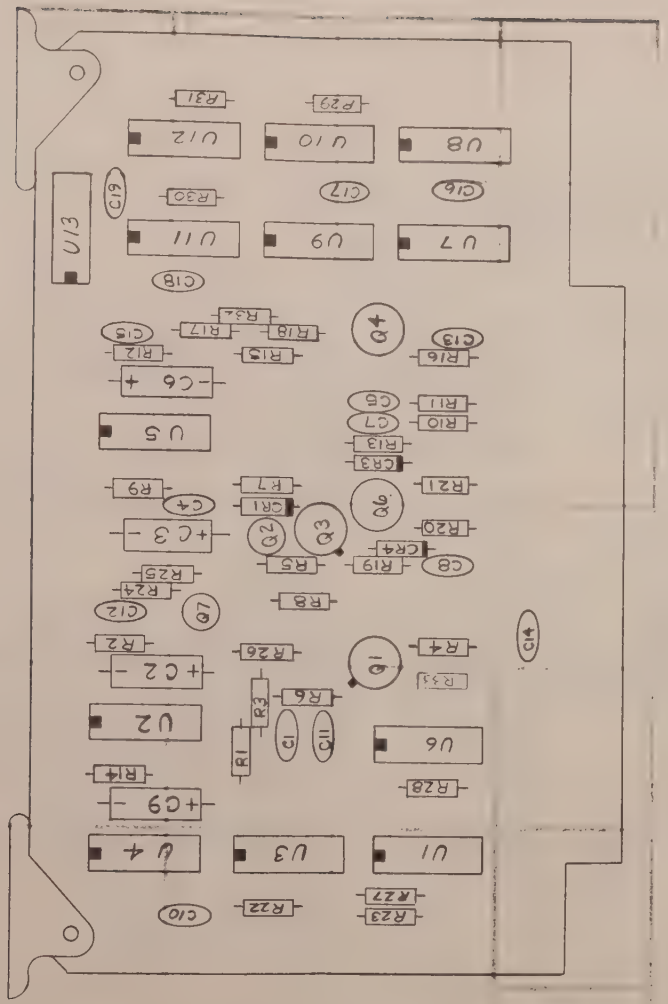
SWITCHES		
S1	C1	40P84250604
S2	C1	40P84250604
S3	C2	40P84250604

RESISTORS		
R1	C2	6K131524
R2		Not Used
R3	B2	6R129669
R4	B1	6S10053A38
R5	A1	18P84309A11
R6	B1	6R131274
R7	B1	6S10053A45
R8	B1	18P84250C32
R9	A1	6R131525
R10		Not Used
R11	B1	6K129806
R12	B2	6R129431
R13	A2	6K129818
R14	A2	6S124A23
R15	B2	6R131275

RESISTORS		
Ref.	Index	Motorola No.
R16	B2	6R131274
R17	A2	6K131524
R18	B2	6R131274
R19	C2	6R129805
R20	B2	6S185A17
R21	B2	6S185A09
R22	B2	6S10053A45
R23	A2	18P84309A13
R24	B2	6S185A09
R25	B3	6R131289
R26	C4	6R129669
R27	C6	6R129708
R28	B3	6R131525
R29	B3	6S185A19
R30	B3	18P84250C32
R31	C5	6R129804
R32	B3	6P84309A08
R33	A3	6P84309A08
R34	B3	6S185A18
R35	B3	6S10053A45
R36	B4	6S185A19
R37	B4	6S185A29
R38	D2	6R129982
R39	A4	6R129779
R40	D3	6R129981
R41	B4	6S10053A23
R42	C3	6R131274
R43	C2	6R129805
R44	C3	6K129681
R45	D3	6R129237
R46	D2	6R129981
R47	C3	6R129805
R48	C5	6R129669
R49	C5	6R129805
R50	C5	6R129804
R51	C5	6R129805
R52	B4	6R131274
R53	A4	Sel. Resistor
R54	C6	6S10053A45
R55	B4	6R129805
R56	C4	6K131524
R57	D5	6K131524
R58	D5	6K131524
R59	C5	6K131524
R60	D2	6S185A45
R61	B1	6S129984



200MHz AMPLIFIER & DECADE
SCHEMATIC 73P84250C35



CONTROL, RESET, & TIMEBASE DIVIDER P.C. ASSEMBLY 1P84250C26

CONTROL, RESET, & TIME BASE DIVIDER
P.C. ASSEMBLY 1P84250C26

CAPACITORS

Ref.	Index	Motorola No.
C1	B2	8P84309A35
C2	A2	23P84309A36
C3	B3	23P84309A37
C4	B3	8P84309A38
C5	C4	21P84309A25
C6	B4	23P84309A39
C7	C4	21P84309A25
C8	C3	21P84309A26
C9	A2	23P84309A31
C10	B1	8P84309A29
C11	B2	8P84309A29
C12	A3	8P84309A29
C13	C5	8P84309A29
C14	D3	8P84309A29
C15	A5	8P84309A29
C16	C5	21P84309A26
C17	C5	21P84309A26
C18	B5	21P84309A26
C19	A5	21P84309A26

INTEGRATED CIRCUITS

Ref.	Index	Motorola No.
U1	C1	51P84309A73
U2	A2	51P84309A73
U3	B1	51P84309A73
U4	A1	51P84309A73
U5	A4	51P84309A73
U6	C2	51P84309A73
U7	C5	51P84309A76
U8	C6	51P84309A76
U9	B6	51P84309A76
U10	B6	51P84309A76

INTEGRATED CIRCUITS

Ref.	Index	Motorola No.
U11	B5	51P84309A76
U12	B6	51P84309A76
U13	A5	51P84309A76

DIODES

Ref.	Index	Motorola No.
CR1	B4	48P84309A57
CR2		Not Used
CR3	C4	48P84309A57
CR4	C3	48P84309A57

TRANSISTORS

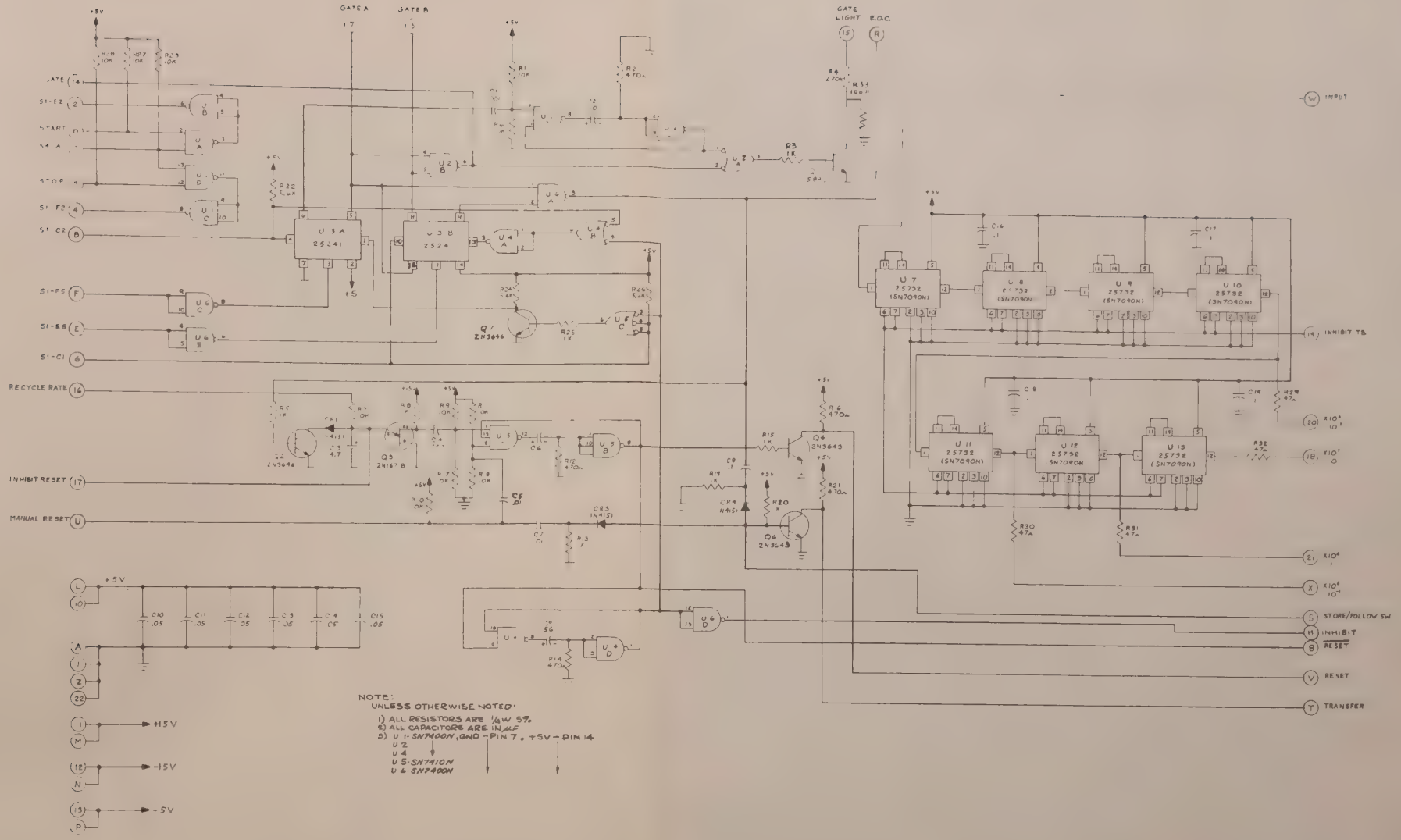
Ref.	Index	Motorola No.
Q1	C3	48P84309A67
Q2	B3	48P84250C32
Q3	B3	48P84309A15
Q4	C5	48P8327D08
Q5		Not Used
Q6	C4	48P8327D08
Q7	B3	48P84250C32

RESISTORS

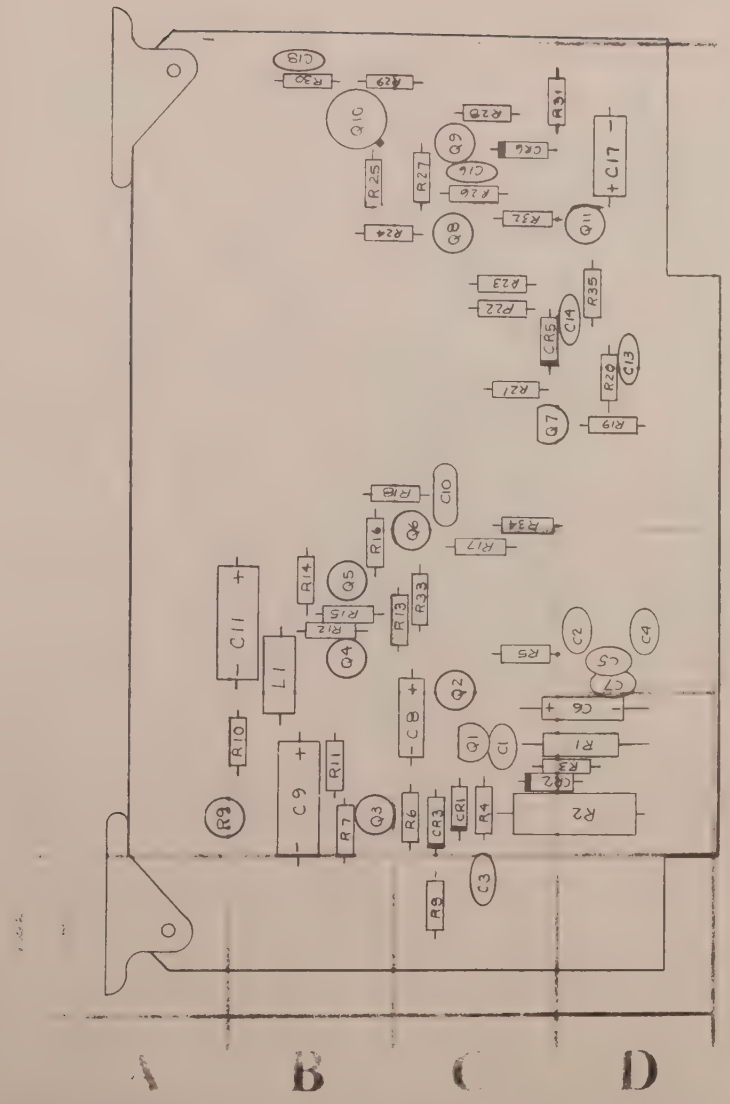
Ref.	Index	Motorola No.
R1	B2	6R129668
R2	A3	6R131274
R3	B2	6R129805
R4	C3	6R131858
R5	B3	6R129805
R6	B2	6R129668
R7	B4	6R129668
R8	B3	6R129805
R9	A4	6R129668
R10	C4	6R129668

RESISTORS

Ref.	Index	Motorola No.
R11	C4	6R129668
R12	A4	6R131274
R13	C4	6R129805
R14	A2	6R131274
R15	B4	6R129805
R16	C4	6R131274
R17	B5	6R129668
R18	B5	6R129668
R19	C3	6R129805
R20	C3	6R129805
R21	C4	6R131274
R22	B1	6R129982
R23	C1	6R129668
R24	A3	6R129982
R25	B3	6R129805
R26	B3	6R129982
R27	C1	6R129668
R28	C2	6R129668
R29	C6	6R131274
R30	B5	6R131274
R31	B6	6R131274
R32	B5	6R131274



CONTROL, RESET & TIMEBASE DIVIDER
SCHEMATIC 73P84250C36



INPUT BUFFER & OVERLOAD PROTECTION P.C. ASSEMBLY 1P84250C27

INPUT BUFFER & OVERLOAD PROTECTION
P.C. ASSEMBLY 1P84250C27

INDUCTOR

Ref.	Index	Motorola No.
L1	B2	24P84309A90

CAPACITORS

C1	C2	
C2	D3	21P84309A25
C3	C1	21P84309A25
C4	D3	21P84309A26
C5	D3	21P84309A26
C6	D2	23P84309A31
C7	D2	21P84309A25
C8	C2	23P84309A31
C9	B2	23P84309A31
C10	C4	
C11	[illegible]	23P84309A31
C12		Not Used
C13	D4	21P84309A25
C14	[illegible]	21P84309A26
C15		Not Used
C16	C6	21P84309A33
C17	D6	23P84309A34
C18	B6	21P84309A25

DIODES

CR1	C2	48P84309A57
CR2	C2	48P84309A57
CR3	C2	48P84309A60
CR4		Not Used
CR5	C5	48P83193A59
CR6	C6	48P84309A57

TRANSISTORS

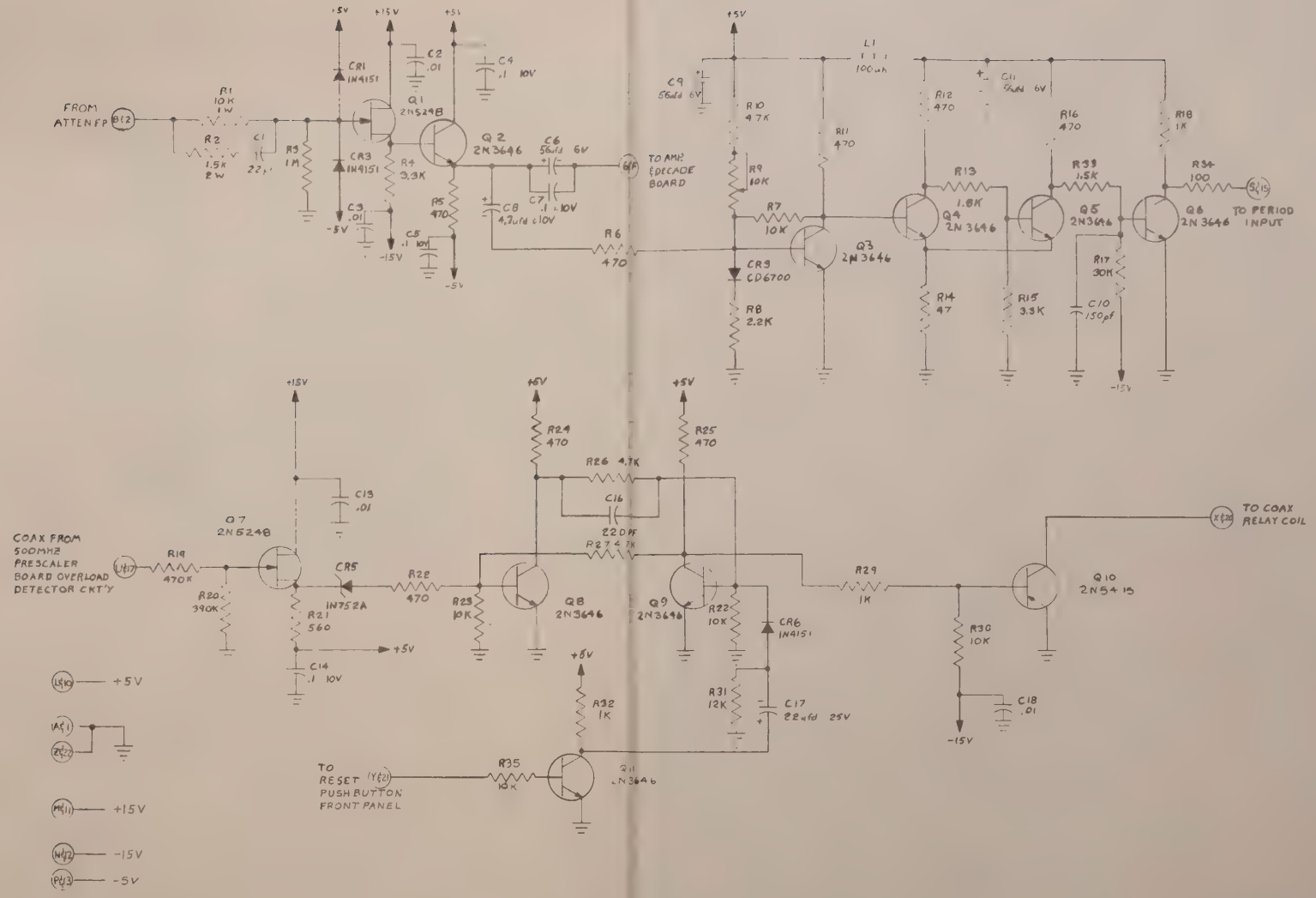
Ref.	Index	Motorola No.
Q1	C2	48P84309A68
Q2	C2	48P84305A20
Q3	B2	48P84305A20
Q4	B3	48P34305A20
Q5	B3	48P84305A20
Q6	C3	48P84305A20
Q7	C4	48P84309A68
Q8	C5	48P84305A20
Q9	C6	48P84305A20
Q10	B6	48P84309A69
Q11	D5	48P84305A20

RESISTORS

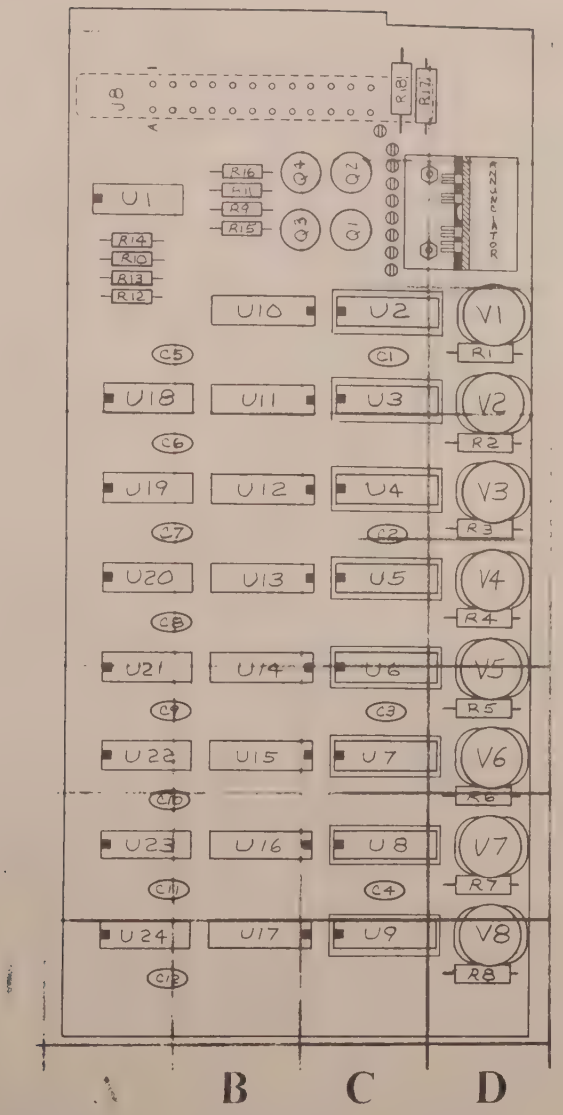
R1	D2	6P84309A14
R2	D2	6P84309A15
R3	C2	6R129189
R4	C2	6R129981
R5	C3	18P84250C32
R6	C2	18P84250C32
R7	B2	6R129668
R8	C1	6R129804
R9	A2	18P84309A16
R10	A2	6R129669
R11	B2	18P84250C32
R12	B3	18P84250C32
R13	B3	6R129820
R14	B3	6R131274
R15	B3	6R129981

RESISTORS

Ref	Index	Motorola No.
R16	B3	18P84250C32
R17	C3	6S124A84
R18	B4	6R129805
R19	D4	6R129124
R20	D4	6P84309A17
R21	C4	6R129779
R22	C5	18P84250C32
R23	C5	6R129668
R24	B5	18P84250C32
R25	B5	18P84250C32
R26	C5	6R129669
R27	C6	6R129669
R28	C6	6R129669
R29	B6	6R129805
R30	B6	6R129668
R31	C6	6S124A75
R32	C5	6R129805
R33	C3	5K129681
R34	C3	6K131524
R35	D5	6R129668



INPUT BUFFER & OVERLOAD PROTECTION
SCHEMATIC 73P84250C37



8 DIGIT READOUT P.C. ASSEMBLY 1P84250C29

8 DIGIT READOUT P.C. ASSEMBLY 1P84250C29

CAPACITORS

Ref	Index	Motorola No.
C1	C6	21P84309A30
C2	C5	21P84309A30
C3	C3	21P84309A30
C4	C2	21P84309A30
C5	A6	8P84309A29
C6	A5	8P84309A29
C7	A5	8P84309A29
C8	A4	8P84309A29
C9	A3	8P84309A29
C10	A2	8P84309A29
C11	A2	8P84309A29
C12	A1	8P84309A29

INTEGRATED CIRCUITS

U1	A7	51P84309A73
U2	C6	51P84309A74
U3	C6	51P84309A74
U4	D5	51P84309A74
U5	C4	51P84309A74
U6	C3	51P84309A74
U7	C3	51P84309A74
U8	C2	51P84309A74
U9	C1	51P84309A74
U10	B6	51P84309A75
U11	B6	51P84309A75
U12	B5	51P84309A75
U13	B4	51P84309A75
U14	B3	51P84309A75
U15	B3	51P84309A75

INTEGRATED CIRCUITS

Ref.	Index	Motorola No.
U16	B2	51P84309A75
U17	B1	51P84309A75
U18	A6	51P84309A82
U19	A5	51P84309A76
U20	A4	51P84309A76
U21	A3	51P84309A76
U22	A3	51P84309A76
U23	A2	51P84309A76
U24	A1	51P84309A76

TRANSISTORS

Q1	C7	48P84309A67
Q2	C7	48P84309A67
Q3	B7	48P84309A67
Q4	B7	48P84309A67

READOUT TUBES

V1	D6	-NL950S
V2	D6	-NL950S
V3	D5	-NL950S
V4	D4	-NL950S
V5	D3	-NL950S
V6	D3	-NL950S
V7	D2	-NL950S
V8	D1	-NL950S

RESISTORS

R1	D6	6R5786
R2	D5	6R5786

RESISTORS

Ref.	Index	Motorola No.
R3	D5	6R5786
R4	D4	6R5786
R5	D3	6R5786
R6	D2	6R5786
R7	D2	6R5786
R8	D1	6R5786
R9	A7	6R129805
R10	A7	6R129668
R11	A7	6R129805
R12	A6	6R129668
R13	A7	6R129668
R14	A7	6R129668
R15	A7	6R129805
R16	A7	6R129805
R17	C8	6R400294
R18	C8	6R400057

ANNUNCIATOR ASSEMBLY

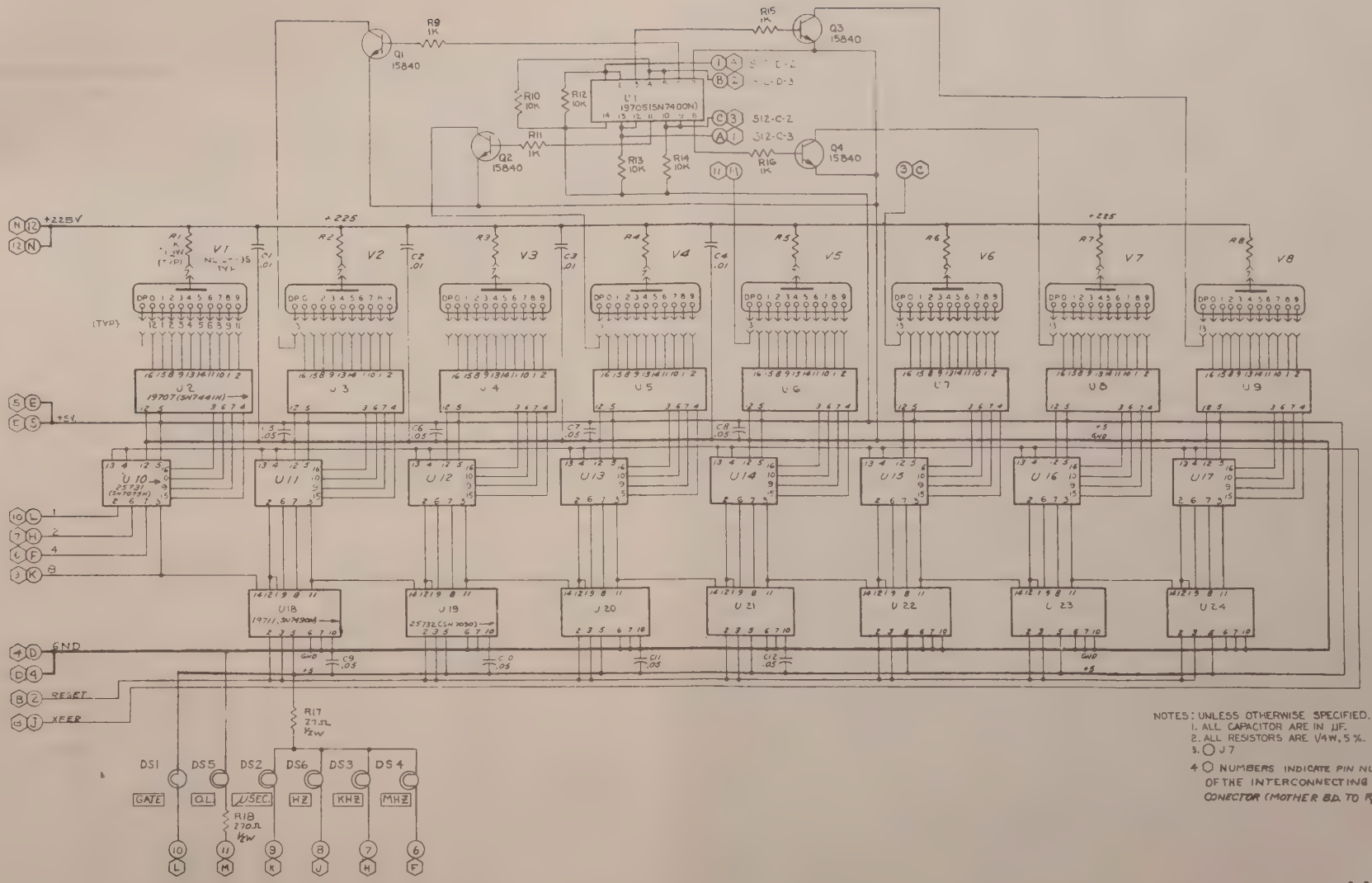
	D7	1P84250C28

SOCKETS, READOUT TUBE

XV1	D6	9P84250C06
XV2	D6	9P84250C06
XV3	D5	9P84250C06
XV4	D4	9P84250C06
XV5	D3	9P84250C06
XV6	D3	9P84250C06
XV7	D2	9P84250C06
XV8	D1	9P84250C06

CONNECTOR

J8	A8	28P84250C17



NOTES: UNLESS OTHERWISE SPECIFIED.
1. ALL CAPACITOR ARE IN μF.
2. ALL RESISTORS ARE 1/4W, 5%.
3. ○ J7
4. ○ NUMBERS INDICATE PIN NUMBERS OF THE INTERCONNECTING P.C. BD CONECTOR (MOTHER BD. TO F/O BD) J8

8 DIGIT READOUT
SCHEMATIC 73P84250C38

ASSEMBLIES

Motorola No.	Description
1P84250C15	500 MHz Prescaler Board
1P84250C22	Power Supply & 1 MHz Shaper
1P84250C23	Mother Board
1P84250C24	Relay
1P84250C26	Control, Reset, & Time Base
1P84250C27	Input Buffer & Overload Protection
1P84250C28	Annunciator
1P84250C29	8 Digit Readout
1P84250C30	Front Cover
1P84250C31	200 MHz Amp & Decade
26P84250C25	Shield, Attenuator
61P84250C20	Filter, Polaroid
64P84250C21	Front Panel, Decorative
84P84250C19	Interconnecting Board

SUBASSEMBLIES

Motorola No.	Description
1P84250C32	Front Panel Subassembly
1P84250C33	Rear Panel Subassembly
1P84250C34	Right Gusset Assembly

SCHEMATICS

Motorola No.	Description
73P84250C32	S1324A Block Diagram
73P84250C33	Power Supply & 1 MHz Shaper
73P84250C34	500 MHz Prescaler
73P84250C35	200 MHz Amp & Decade
73P84250C36	Control, Reset, & Time Base
73P84250C37	Input Buffer & Overload Protection
73P84250C38	8 Digit Readout

CAPACITORS

Motorola No.	Description
8P84309A29	.05 µF
8P84309A35	.001 µF
8P84309A38	.002 µF
8P84309A51	.1 µF 100V
21P84309A23	.056 pF
21P84309A24	15 pF, Chip
21P84309A25	.01 µF, 100V, Disc
21P84309A26	.1 µF, 10V, Disc
21P84309A27	22 pF
21P84309A28	56 pF

CAPACITORS (Cont'd)

Motorola No.	Description
21P84309A30	.01 µF, 500 V, Disc
21P84309A33	220 pF
21P84309A40	2 pF, Mica
21P84309A41	10 pF
21P84309A42	15 pF
21P84309A43	1 pF
21P84309A44	100 pF
21P84309A49	.001 µF, 500V, Disc
21P84250C32	22 pF
21P84250C33	150 pF
21P84250C34	1 pF
23P84309A31	56 µF
23P84309A32	4.7 µF
23P84309A34	22 µF
23P84309A36	10 µF, 6V
23P84309A37	4.7 µF
23P84309A39	.1 µF, 35V
23P84309A45	1350 µF, 50V
23P84309A46	80 µF, 300V
23P84309A47	5000 µF, 10V
23P84309A48	500 µF, 50V
23P84309A50	1 µF, 100V

CONNECTORS

Motorola No.	Description
28P84250C16	BNC
28P84250C17	24 Pin, Dual 12

DIODES

Motorola No.	Description
48C82525G07	1N4719
48D83461E12	1N4750A
48P83193A59	1N752A
48P83624E03	1N966B
48P83698E06	1N4005
48P83698E07	1N4370
48P84309A52	FD700
48P84309A53	TD254A
48P84309A54	TD253B (Matched Set)
48P84309A55	TD253B
48P84309A56	19330
48P84309A57	1N4151
48P84309A58	HP5082-2800
48P84309A59	25287
48P84309A60	6700
48R84302A09	1N753A

INTEGRATED CIRCUITS

Motorola No.	Description
51P84309A71	SN1584BN
51P84309A72	SN7473N
51P84309A73	SN7400N
51P84309A74	SN7441B
51P84309A75	SN7075N
51P84309A76	SN7030N
51P84309A77	SN7474N
51P84309A78	SN7410N
51P84309A79	MC1023P
51P84309A80	MC1027P
51P84309A84	MC1012P

LAMPS

Motorola No.	Description
65P84309A80	Neon Lamp
65P84309A81	Incandescent Lamp
NL950S	Readout Tube, NL950S

SWITCHES

Motorola No.	Description
24P84209A89	Reed Switch
24P84209A90	Reed Switch
51P84309A83	Peaking Network

RESISTORS

Motorola No.	Description
6R129149	470K, 1/4W, 5%
6P84309A12	Thermistor, Temp. Sensing
6P84309A13	10K, 1W, 5%
6P84309A15	1.5K, 2W, 5%
6P84309A21	910K, 1/4W, 5%

RESISTORS (Cont'd)

Motorola No.	Description
6R129149	470K, 1/4W, 5%
6R129669	4.7K, 1/4W, 5%
6R129982	3.3K, 1/4W, 5%
6R131274	47K, 1/4W, 5%
6R131275	220K, 1/4W, 5%
6R131276	150K, 1/4W, 5%
6R131277	910K, 1/4W, 5%
6R131278	200K, 1/4W, 5%
6R131279	2.7K, 1/4W, 5%
6R131280	1.8K, 1/4W, 5%
6R131281	3.3K, 1/4W, 5%
6R131282	5.6K, 1/4W, 5%
6R131284	680K, 1/4W, 5%
6R131285	1.2K, 1/4W, 5%
6R131286	2.7K, 1/4W, 5%
6R131287	390K, 1/4W, 5%
6R131288	47K, 1/4W, 5%
6R131289	100K, 1/4W, 5%
6R131290	1.2K, 1/4W, 5%
6R131291	30K, 1/4W, 5%
6R131292	100K, 1/4W, 5%
6R131293	22K, 1/4W, 5%
6R131294	1.2K, 1/4W, 5%
6R131295	2.2K, 1/4W, 5%
6R131296	24K, 1/4W, 5%
6R131297	27K, 1/4W, 5%
6R131298	33K, 1/4W, 5%
6R131299	47K, 1/4W, 5%
6R131300	51K, 1/4W, 5%
6R131301	82K, 1/4W, 5%
6R131302	1.5K, 1/4W, 5%
6R131303	430K, 1/4W, 5%

RESISTORS (Cont'd)

Motorola No.	Description
18P84250C32	470Ω, 1/4W, 5%
18P84250C33	1K, temp. Sensing
18P84250C34	43 ., 1/8W, 5%
18P84309A06	200Ω, Pot. (S.T.)
18P84309A07	200Ω Pot (Multiturn)
18P84309A11	1K, Pot.
18P84309A13	100Ω, Pot
18P84309A16	10K, Pot
18P84309A20	100Ω, Pot
18P84309A22	2M, Pot. with switch

SWITCHES

Motorola No.	Description
40P84250C01	4PDT Slide
40P84250C02	SPDT Toggle
40P84250C03	11 Pos. I.B.
40P84250C04	Reed .15W
40P84250C05	4PDT
40P84309A99	DPDT Toggle

TRANSFORMERS

Motorola No.	Description
25P84309A85	Transformer
25P84309A86	Transformer

TRANSISTORS

Motorola No.	Description
48P83102A15	2N1671B
48P83699E64	2N3638
48P83827D08	2N3643
48P84250C23	15840
48P84302A51	2N3568
48P84302A70	2N4918
48P84305A20	2N3640
48P84309A61	2N5179
48P84309A62	2N4260
48P84309A63	2N3640
48P84309A64	19420
48P84309A65	SM2813
48P84309A66	14092
48P84309A67	15840
48P84309A68	2N5248
48P84309A69	2N5415
48P84309A70	2N4921

MISCELLANEOUS

Motorola No.	Description
9P84250C08	Socket, Readout Tube
15P84250C12	Fan Cover
35P84250C11	Fan Screen
49P84250C08	Fan Blade
59P84250C09	Fan Motor
64P84250C10	Fan Filter
65P84250C07	Fuse Holder
36P84309A97	Knob
42P84309A96	Clamp
51P84309A95	Heatsink
64P84309A94	Transistor Pad
65P84309A98	1A 3 AG SLO-BLO
66P84309A93	Extractor
76P84309A92	Ferrite Bead
K1001A ASP03	Osc. 3MHz
30P84250C18	Line Cord
61P84250C20	Filter, Polaroid
84P84250C19	Interconnecting Bd.

Chapter 7

STANDARD OPTIONS

7.1 INTRODUCTION

The Standard Options available for the Model 5324A Counter are described in the following sections. These are extra cost items to tailor your unit for specific application. Non-Standard Options may be requested and will be described in this chapter when applicable.

BATTERY OPTION
MODEL SLN1006A

The SLN1006A Battery Option is a source of 115V ac 60Hz power to operate the S1324A Digital Frequency Meter. The S1324A power cord should be connected to the 115V OUT receptacle of the SLN1006A. The SLN1006A may be operated from 115 or 230 volt 60Hz ac, or from an external 12 volt 6 amp dc source, or from its two internal batteries. Each of the battery pack's 3 modes of operation is discussed below. Note that all controls are on the rear panel of the S1324A except the BATT. OPER. (momentary battery operation pushbutton) switch which is on the S1324A front panel.

1) 60Hz ac Operation:
   A. Set S3 to "115" or "230" as appropriate for the source voltage. Ensure that the proper value fuse F2 is installed, and then connect the SLN1006A power cord to a power outlet. Set S2 to "AC"; 115 volts (sine wave) will be present at J1. In this mode the thermal switch (which controls the S1324A cooling fan) is bypassed, resulting in continuous fan operation.

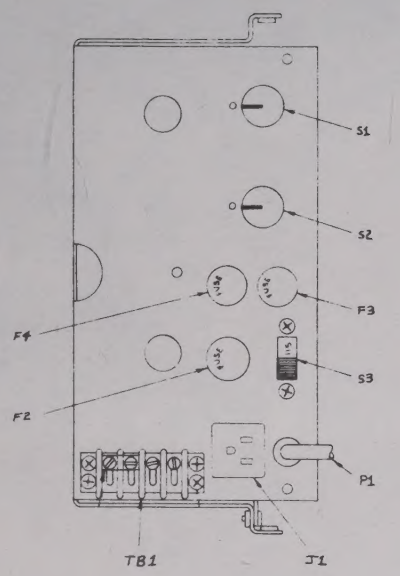
   B. When the SLN1006A is connected to ac power, the internal battery may be charged at a rate selected by S1. A fully discharged battery will recharge in approximately 12 hours if the FAST rate is selected. The battery may be charged continuously at the TRICKLE rate.

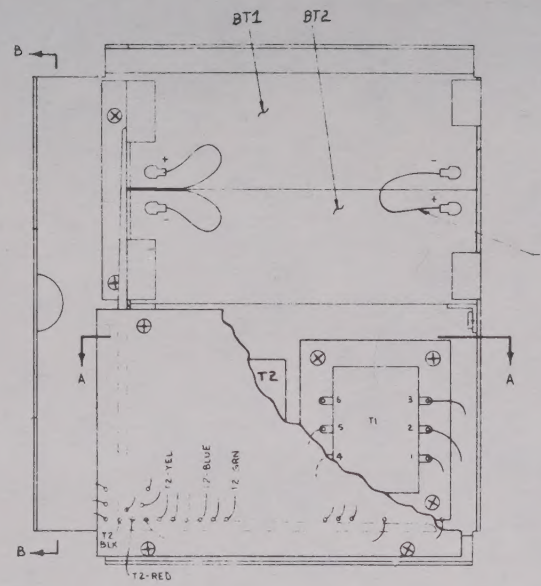
2) External 12 Volt dc Source Operation:
   Install the jumper between terminals 2 & 3 of TB1. Connect the source positive to terminal 3 and source negative to terminal 4. The SLN1006A is wired such that whenever 12 volts is applied across these two terminals, the inverter (consisting of T2, Q1, Q2 and associated components) operates. The output of T2 (115V rms, 60±10Hz square wave) is present at J1 if S2 is set to BATT., OFF. This feature is based on the assumption that the external source has a high ampere-hour capacity (vehicle battery, etc.) The continuous ac output enables the S1324A heated oscillator to stabilize. (The oscillator is wired to operate whenever the instrument is connected to ac Power.)

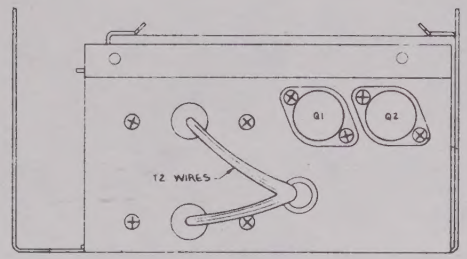
3) Internal Battery Operation:
   The self-contained batteries are rated at 7.5 ampere-hours, which provide a minimum of 1 hour operation of the S1324A. Install the jumper between terminals 1 & 2 of TB1.
   A. Momentary operation in this mode is enabled by setting S2 OFF and depressing the BATT. OPER. pushbutton (S1324A front panel). The inverter will supply 115V ac as long as the switch is held down. NOTE: Reading accuracy is decreased because of oscillator warm-up requirements.

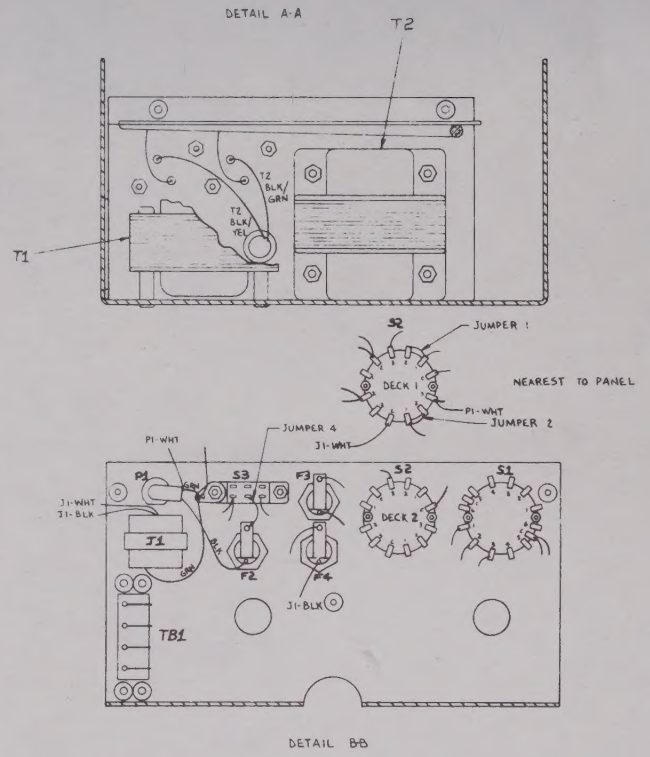
   B. Continuous operation is obtained by setting S2 to BATT. The inverter will run until battery capacity is exhausted.

NOTE: In modes 2, 3A, & 3B, the S1324A cooling fan operates intermittently to conserve battery life. The fan is controlled by a thermal switch in the S1324A and turns on when the instrument reaches an internal temperature of 40°C.

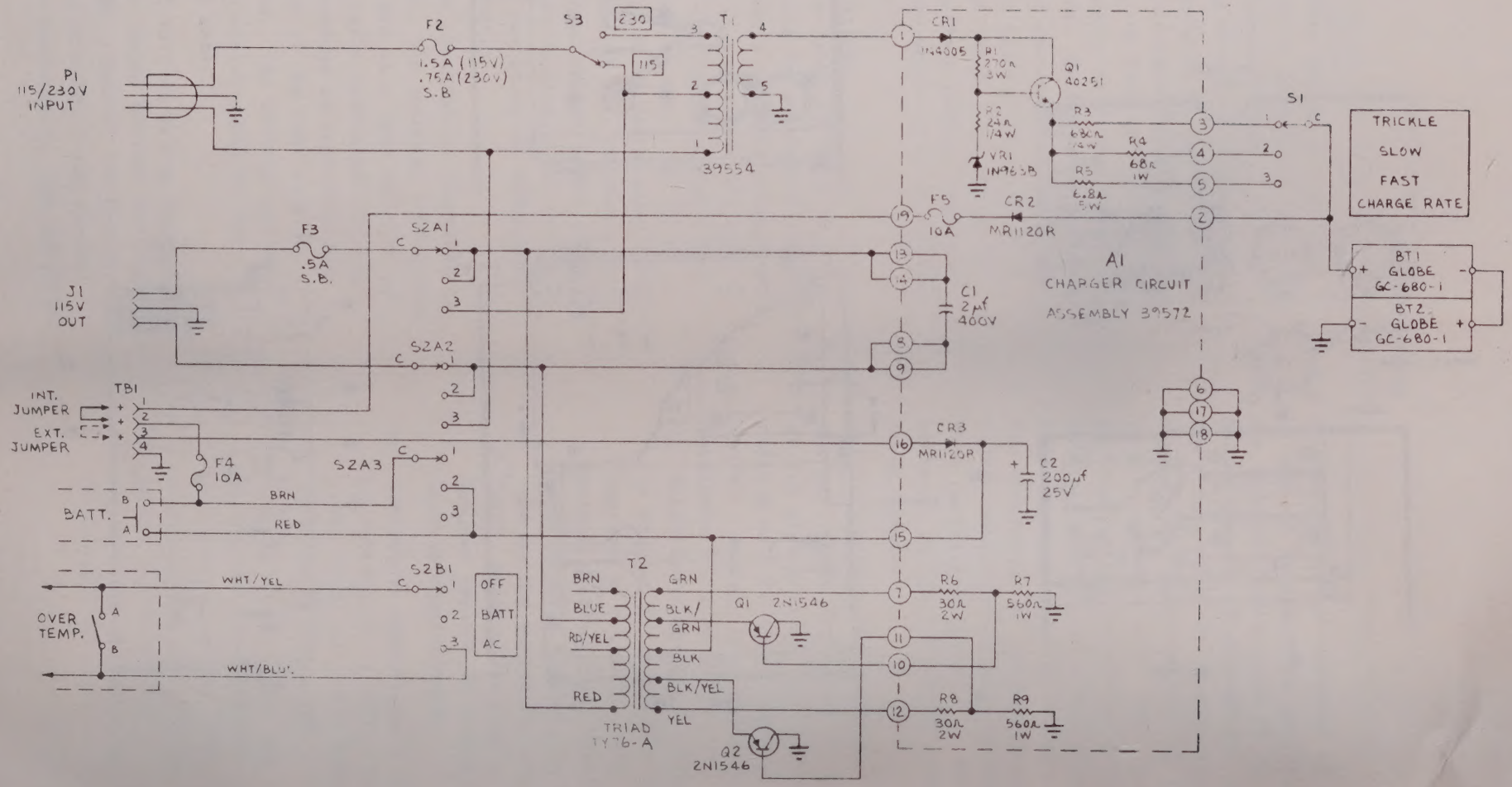








FINAL ASSEMBLY 1P84250C74



BATTERY PACK SCHEMATIC 63P84250C73